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Land resource survey and evaluation of the Kilcummin area, Queensland

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Queensland Department of Primary Industries

Queensland Government Technical Report

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Summary

The Kilcummin area is located 150 km north-west of Emerald in Queensland's Central Highlands. This area was a priority choice for detailed land resource survey and land suitability assessment because of its variety of easily cultivated lands, marginal rainfall regime and position in an expanding cropping area.

During the study, 35 soil profile classes, seven phases, six variants and one group of miscellaneous soils were identified. Detailed morphological and analytical data are presented for each soil, the relationships between soils are discussed and their distribution is shown on the accompanying soils map. Summary descriptions of the climate, geology, landform, vegetation and extent of land degradation are also given. A total of 703 unique map areas (UMAs) were delineated during soil mapping. For each UMA the location, size, geology, soils, landform and vegetation were recorded on a readily accessible computer data file.

Every UMA was assessed for its suitability for rainfed cropping and for beef cattle grazing using a five class system. The relevant limitations and suitability classes were recorded on the computer data file containing the land resource inventory. The five suitability classes for beef cattle grazing cover a range of six potential enterprises from grazing sown pastures to grazing only low quality native pastures. The UMAs were allocated to one of these specific options and were also placed into one of two groups reflecting their overall suitability for rainfed cropping. The specific grazing enterprise option and overall cropping suitability were recorded for each UMA on the computer data file. The combination of overall crop suitability and grazing enterprise options was used as the basis for preparing for a land suitability map for agriculture.

Approximately half the area (54%) is considered suitable land for rainfed cropping. Almost 19% is also suitable land for grazing a range of sown pastures, the remainder being suitable for grazing only a limited of sown pastures but comprising highly productive native pastures. The soils are deep clays without melonhole gilgai or soluble salts close to the surface and on gently undulating topography. These lands can be developed for both cropping and grazing sown pastures or the latter can be used for grazing highly productive native pastures.

The other 46% of the area is considered unsuitable for cropping. This includes 13% of the area classified as marginal cropping land, on which it is doubtful whether crop yields will outweigh the inputs required to achieve and maintain production in the long-term. Most of the marginal cropping land is suitable for grazing (either a range or a limited number of) sown pastures. Development for sown pastures are recommended options for this land. The remaining marginal cropping land is also considered only marginal land for grazing sown pastures and should be not be developed for either use. Some areas of the marginal cropping land are suitable for grazing highly productive native pastures.

There is no doubt that the remaining 33% of the area is unsuitable cropping land. Almost all of this land is either suitable for grazing highly productive native pastures (6%), suitable for grazing low quality native pastures oversown with shrubby stylos (almost 13% of the area), or is suitable for grazing low quality native pastures only (10%). The remainder is either marginal or suitable (< 1%) land for grazing sown pastures with low quality native pastures. These lands should not be cropped and should only be developed for sown or improved pastures where suitable.

1. Introduction

Rainfed, broadacre cropping is expanding rapidly in central Queensland. The cultivated area more than trebled between the 1966 to 1970 period and the 1981 to 1985 period and is expected to almost treble again by the turn of the century (Table 1). This expansion is occurring on the more productive lands resulting in increased grazing pressure being placed on the remaining lower quality lands to maintain overall beef production. The changes to more intensive cropping and grazing land uses have resulted in a demand for more detailed land management recommendations which, in turn, requires greater knowledge of the land resources. At present, land resource data are available at only a very broad scale for much of the region and are inadequate for more detailed regional planning, agricultural feasibility and property planning purposes.

Table 1. Area used for cereal, oilseed and cotton production in central Queensland

Year	Mean Area ('000 ha)	Comments
1966-1970[1]	158	
1971-1975[1]	230	Five year averages
1976-1980[1]	312	
1981-1985[1]	545	
2000[2]	1 504	Projection estimates

Source: [1] Australian Bureau of Statistics
[2] Queensland Planning Committee on Future Grain and Oilseed Handling, Storage and Transport Report, 1981

Estimates of the area of cropping land available in central Queensland vary considerably. Gillies (1978) estimated that as much as 10.7 m ha could be readily cultivated, although Weston *et al.* (1981) considered only 3.7 m ha are suited to long-term cropping. It would be an enormous task involving at least 150 man years, to survey and document the resources of such an extensive area in sufficient detail for detailed regional and individual property planning. An alternative approach was adopted in which a series of priority sample areas representing these lands were selected (Shields and Turner 1985). The land resources of these priority areas are to be surveyed in detail and recommendations for sound land use management made. Results can then be extrapolated to surrounding areas.

The Kilcummin 1:100 000 map sheet (number 8453) was chosen as a priority sample area because of its variety of easily cultivated soils, its marginal rainfall regime, its position in an expanding cropping area and the minimal experience of cropping in the area.

The specific objectives of the study were:

. to survey and document the land resources of the Kilcummin area in sufficient detail for subsequent land suitability classification;

. to use the land resource inventory as a basis for classifying land suitability for rainfed cropping and for beef cattle grazing; and

. to recommend appropriate agronomic and soil conservation practices to maintain productivity of all lands.

2. The Kilcummin area

2.1 Location and size

The Kilcummin 1:100 000 map sheet is located on the north-western edge of Queensland's Central Highlands (Figure 1). Its centre is approximately 150 km north-west of Emerald and 190 km south-west of the coastal city of Mackay.

The northern and southern boundaries are formed by latitudes 22°S and 22° 30'S respectively. The longitudes 147° 30'E and 148°E represent the western and eastern boundaries respectively. They encompass an area of approximately 285 000 ha.

2.2 Present land use

Rainfed, broadacre cropping and grazing beef cattle are the predominant land uses of the surrounding region. Most landholders have a mixture of both, although the ratio of cropping to grazing is quite variable. A "typical" mixed enterprise consists of 1200 ha of cultivation and 2500 head of cattle but property size can vary from as little as 1200 ha of cropping only, up to 95 000 ha used solely for grazing.

Cropping is opportunistic with rainfall determining whether summer or winter crops are grown. Within this major constraint, there is generally an attempt by farmers to have a summer-winter crop rotation. Fallowing between crops is not generally practised and very few farmers apply fertilisers. The crops grown in the area include sorghum, sunflower, wheat, safflower, dryland cotton, forage crops and, to a very minor extent, chickpeas and mungbeans. Each crop has a confined planting period and the actual time of the year in which rain falls is a major factor governing which particular summer or winter crop is planted. The timeliness of operation is critical for planting summer crops in this region. Each planting area has to be planted within a five day period because the high evaporation rates quickly dry out the seedbed. As a result, machinery with a capacity to quickly cover large areas is used. Tractors over 375 kW power and planting machinery over 20 m wide are common. The crops are planted in rows and press wheels are generally used to improve soil-seed contact but fertilisers are not usually applied.

The principal grazing enterprise is breeding and fattening cattle although there is some turn-off of cattle in store condition. Both native and sown pastures are utilised. The native pastures consist of:

- Queensland bluegrass and Queensland bluegrass-mitchell grass grasslands with occasional eucalypt open woodlands; and

- lower quality tussock grasses under eucalypt woodlands and bendee or lancewood open forests.

The brigalow and gidgee scrub are mainly cleared and sown to buffel grass. Both stocking rate and liveweight gains are higher on the sown pastures than on the Queensland bluegrass and Queensland bluegrass-mitchell grass grasslands which, in turn, are higher than on the lower quality tussock grasses. Steer carcases in the range of 220 to 300 kg can be produced on the sown pastures at 28 to 40 months of age but an extra three to six months are required on the grasslands (Rudder 1977). These weights would not be achieved until 48 to 60 months of age on the lower quality tussock grasses and the carcases are suitable only for the manufacturing meat market.

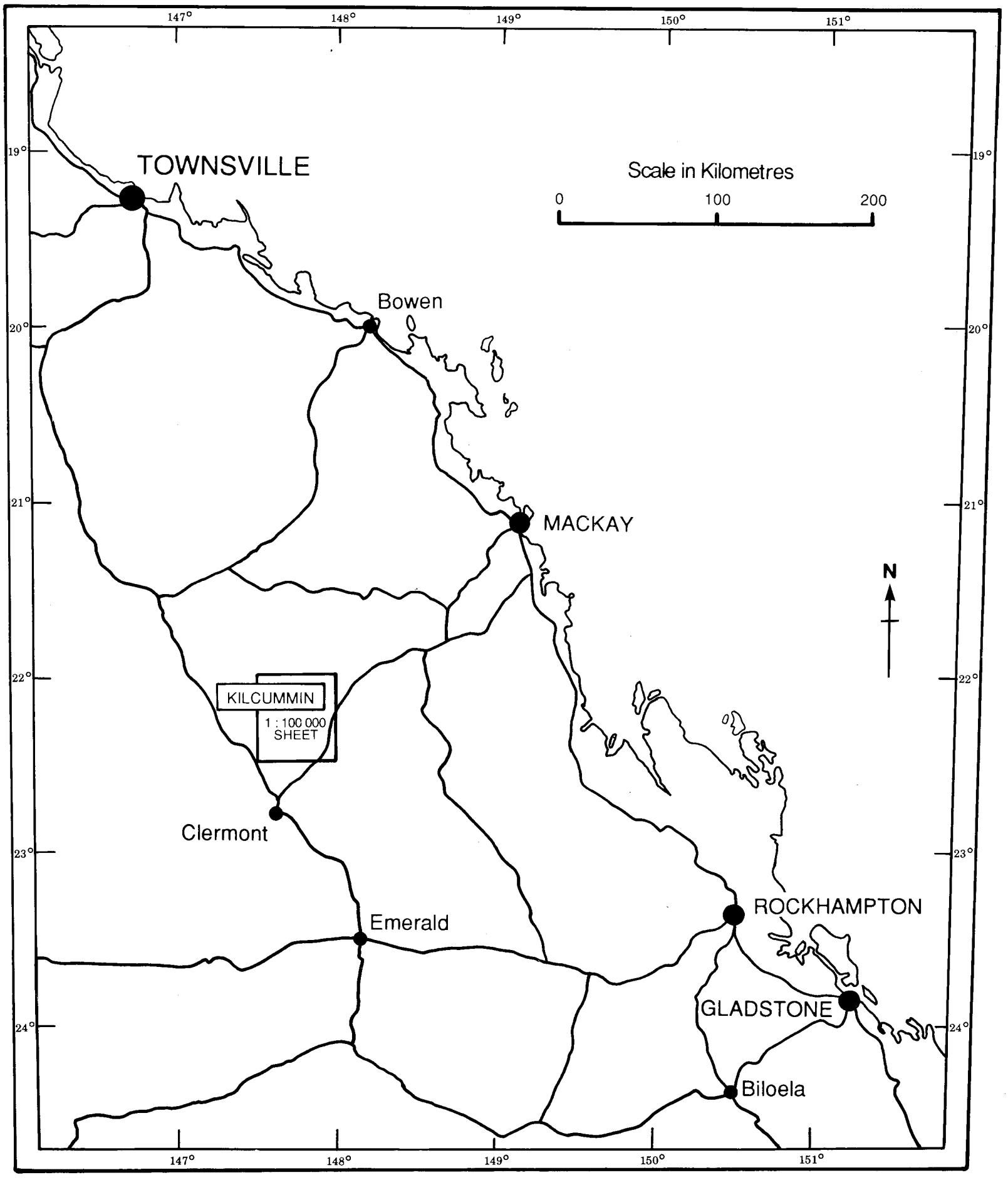


Figure 1. Locality map of the Kilcummin study area

3. Survey method

3.1 Soil mapping

The soils of the Kilcummin area were mapped at 1:100 000 scale in order to compile a resource inventory appropriate for evaluating the agricultural potential.

Field work involved an initial inspection of the entire sample area to gain an insight into the soil landscapes, followed by a mapping phase. All field observations were recorded according to McDonald *et al.* (1984a) and the data were stored on computer files.

During the initial reference making phase 63 traverses were selected to inspect all land systems mapped by CSIRO (Gunn *et al.* 1967, Story *et al.* 1967) within the sheet area. A total of 312 sites were inspected and described along these traverses. The sites were located a maximum 300 m apart at varying topographic positions and were exposed by 75 mm hand auger to at least 1.5 m, bedrock or gravel, whichever was shallower. The descriptions were used to define preliminary soil profile classes based on their similarity of morphological and landscape attributes. The soil profile classes were named after a locality where each occurs.

In the subsequent mapping phase an additional 1285 sites were described using a combination of 50 mm thin walled hydraulic sampling tube and 75 mm hand auger. Free survey techniques were used to select these sites and check soil boundaries.

The soils were mapped as compound mapping units. These units generally contain 60% or more of one soil profile class, with a minor occurrence of associated soils which cannot be separated at the scale of mapping. However, more complex mapping units in which there is no dominant soil also occur. The mapping units were plotted on 1:25 000 black and white aerial photographs and transfered to a 1:100 000 cadastral base map. The smallest areas delineated were 3 to 5 ha.

After completing the mapping phase, descriptions of the soil profile classes were finalised using all the available site data.

3.2 Soil analysis

A total of 55 soil profiles were sampled for detailed laboratory characterisation. These profiles represent the major soil profile classes, variants and phases identified in the area. Location of the sampling sites are shown on the enclosed soils map.

The profiles were sampled in 100 mm increments to approximately 1 500 mm depth, where possible. This procedure was varied to sample thin surface horizons and to avoid sampling across important horizon boundaries. A bulk (0 to 100 mm) surface sample (composite of 8 to 10 subsamples) was also collected for surface fertility assessment. A number of laboratory analyses were performed on samples taken from standard depths in the representative profiles (Table 2). In addition to the these analyses, pH, Electrical Conductivity and % Chloride were determined on all intermediate depths to 1 500 mm depth. The specific analytical methods together with some general data interpretations are listed in Bruce and Rayment (1982).

Analysis of variance was used to test for soil differences in total phosphorus and total potassium at each sampling depth; soil means were compared using the protected LSD test.

Table 2. The range of analyses performed at standard depths in the representative profiles

Soil analysis (Bruce and Rayment 1982)	Sample type and depth (mm)						
	Bulk	Profile					
	0-100	0-100	200-300	500-600	800-900	1100-1200	1400-1500
pH, EC, Chloride	x	x	x	x	x	x	x
Exch. cations, CEC		x	x	x	x	x	
Total P, K, S		x	x	x	x	x	
Organic C, Total N	x						
Acid extractable P	x						
Bicarb. extractable P	x						
Replaceable K	x						
DTPA extr. Fe, Mn, Cu, Zn	x						
Particle size analysis		x	x	x	x	x	
Dispersion ratio		x	x	x	x		
Moisture measurements -							
% Air dry		x	x	x	x	x	
-1500 kPa content		x	x	x	x		

3.3 Resource inventory compilation

Each occurrence of a mapping unit, named a unique map area (UMA), was given a unique number and individually described in terms of its location, area and land resources. The land resource information includes geology, dominant soil, associated soils, landform, dominant plant community and any associated plant community. The proportion of the UMA that contains each soil and plant community is also estimated as is the proportion of the UMA that is cleared. The information was recorded on a UMA computer data file for the 703 UMAs delineated.

The proportion of dominant soil may vary between UMAs for each mapping unit. The estimated proportion of every UMA that each soil occupies is given in the UMA data file. Several UMAs have been recorded as full of the dominant soil profile class indicating that minor areas of other soils were not observed. However, it is unlikely these UMAs are pure and at more intense mapping scales other soils would probably be delineated. In a few UMAs two soils may be co-dominant, in which case the UMA is given the name of the first soil recorded in order to simplify the map reference. These UMAs are indicated in the UMA data file.

3.4 Land suitability evaluation

Every UMA was evaluated for its relative suitability for rainfed cropping and for beef cattle grazing using two separate schemes described in Section 10.

The significant limitations to both crop and beef production in the area were identified following discussions with agronomy and soil conservation extension staff, a literature review and field experience gained during the survey.

For crop production, the specific limitations operating in each UMA were recognised and the severity of every limitation was qualitatively assessed on a 1 to 5 scale in accordance with the five suitability classes used for the scheme:

Class 1 Suitable land with negligible limitations
Class 2 Suitable land with minor limitations
Class 3 Suitable land with moderate limitations
Class 4 Marginal land with severe limitations
Class 5 Unsuitable land with extreme limitations

Each UMA was then placed into one of the five classes, generally determined by the most severe limitation identified. In some cases, the combination of two or more limitations may have been sufficient to downgrade a UMA to a less suitable class. Suitability was determined on the basis that appropriate land conservation measures would be applied.

This process was repeated to assess land suitability for beef cattle grazing.

The five suitability classes for beef cattle grazing cover a wide range of potential enterprises from grazing sown pastures to grazing only low quality native pastures. The productivity of these enterprises and the relative advantage of any pastoral development depends upon the type and severity of limitations that are operating. UMAs were placed into one of six groups in order to represent these specific options. The UMAs were also placed into one of three groups (suitable, marginal and unsuitable) reflecting their overall suitability for rainfed cropping.

The relevant limitations, suitability classes, specific grazing enterprise option and overall cropping suitability were recorded on the computer data file containing the land resource inventory.

The combination of overall crop suitability and grazing enterprise options was used as the basis for preparing an agricultural land suitability map.

Data from the UMA data file is available upon request from the Director, Land Resources Branch, Queensland Department of Primary Industries, Meiers Road, Indooroopilly 4068.

4. Climate

According to Köppen's global classification, the sample area has a hot (mean annual temperature > 18°C), semi-arid climate with a winter dry season and rainfall concentrated in the summer half year (Dick 1975).

4.1 Rainfall

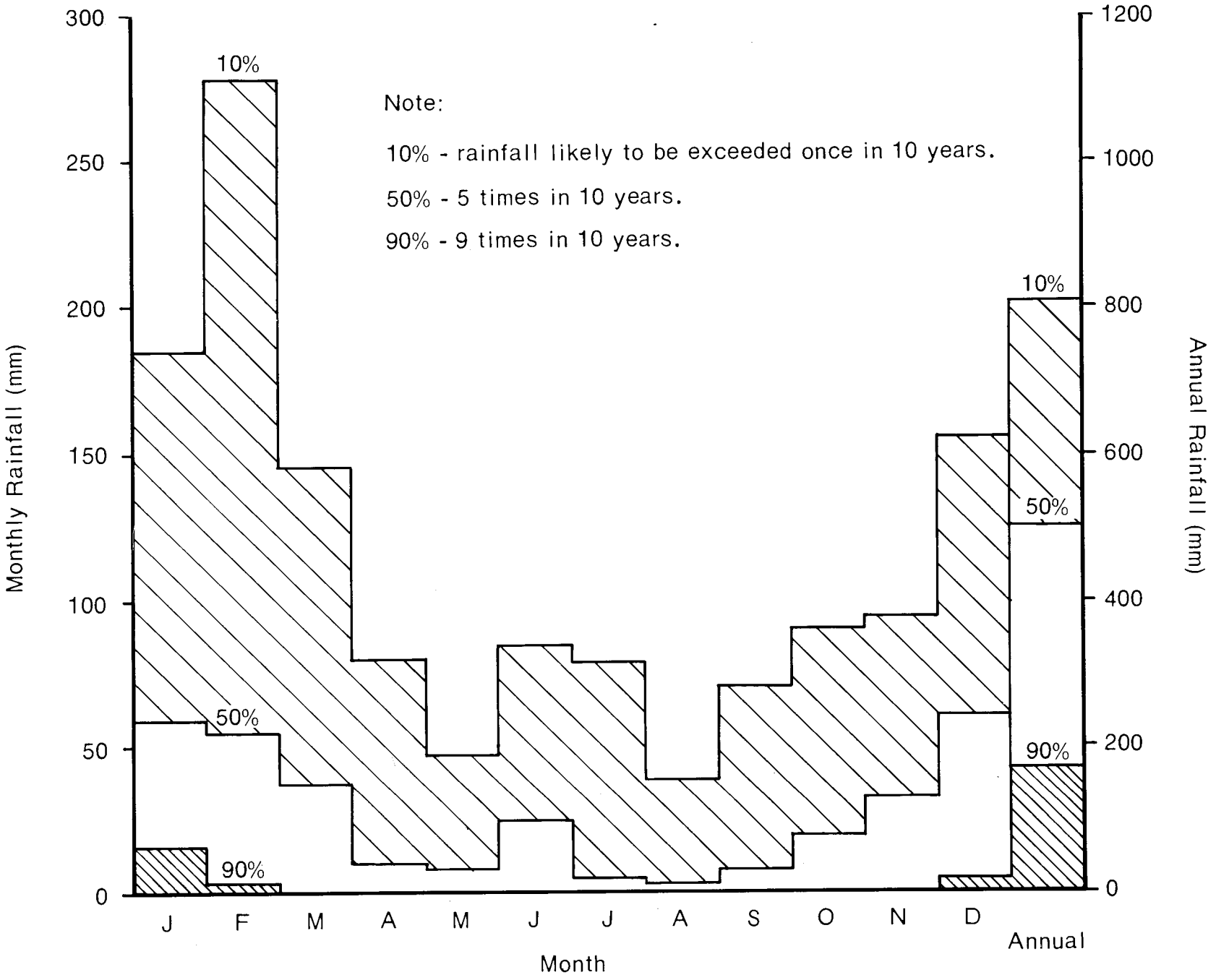
Mean monthly and annual rainfall figures are presented in Table 3 for eight selected stations with at least 25 years of records. An average 60 mm more rain falls annually on the eastern and southern margins than on the remainder of the map sheet. Total rainfall is greater again to the north-west around Twin Hills. However, the entire area has lower mean annual rainfall than the established cropping areas of Emerald (638 mm) and Clermont (675 mm). A marked seasonal distribution is also apparent (Table 3), with an 72 to 75 % of the annual rainfall occurring in the six warmer months October to March.

Table 3. Mean monthly and annual rainfall for seven selected stations

Station (Location)	Period of records	Mean rainfall (mm)												
		J	F	M	A	M	J	J	A	S	O	N	D	Annual
Grosvenor Downs (22 02S 148 05E)	1886-1972	106	90	72	32	25	33	22	23	27	31	43	84	587
Mount Lebanon (22 13S 147 58E)	1954-1987	104	106	68	36	37	17	21	16	13	30	53	88	589
Logan Downs (22 23S 147 56E)	1888-1962	106	116	57	30	25	36	24	16	19	31	48	84	592
Wentworth (22 06S 147 42E)	1963-1987	104	76	60	19	38	16	18	16	11	35	46	96	527
Kilcummin (22 23S 147 31E)	1880-1952	84	102	59	28	19	34	24	13	20	34	43	71	531
Yackadoo (22 26S 147 38E)	1960-1987	96	96	71	28	46	17	15	20	6	29	54	100	592
Mount Wilkin (22 16S 147 26E)	1923-1987	93	100	54	27	30	25	21	13	14	30	47	75	534
Twin Hills (21 57S 146 57E)	1888-1985	120	114	71	37	29	33	22	16	19	28	51	78	618

Source: Bureau of Meteorology

Both seasonal and annual rainfall are highly variable (Figure 2) due to the convective origin of much of the rainfall, and the sporadic incidence of rainfall depressions associated with tropical cyclones.



Source: Bureau of Meteorology.

Figure 2. Monthly and annual rainfall variability for Kilcummin station

Rainfall may be of high intensity. One of the highest 24 hour totals on record for the region was 419 mm which fell at Clermont in 1916 (Bureau of Meteorology 1962). Although there is little other rainfall intensity information available for the area, Rosenthal and White (1980) have estimated an index of rainfall erosivity based on rainfall energy and maximum storm intensity (Table 4). In addition, the average number of rain days and the average number of days during which thunder was heard provide some indication of intensity and are given for Twin Hills in Table 4.

The number of rainfall days at Twin Hills during the November to February period are closely related to the number of days with thunderstorm activity. This suggests that these falls would be relatively intense. The estimated erosion index (EI) supports this with the four warmest months contributing 62% of the annual EI. The annual EI is much higher than for similar broadacre cropping areas further south (Dalby 174, Gunnedah 147).

Table 4. Average number of days with rain and thunder and an estimated rainfall erosion index (EI) for Twin Hills

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Average number of days with-													
Rainfall (≥0.1 mm)[1]	10	8	6	3	4	2	3	2	2	3	6	8	57
Thunder heard[1]	9	5	2	1	1	0	0	0	1	2	6	7	34
Average EI[2]	103	52	16	6	6	3	1	3	11	10	24	70	305

Source: [1] Bureau of Meteorology, recording period 1965 to 1985
[2] Rosenthal and White (1980), based on the 1965 to 1976 period

Hail was recorded only 5 times during the 1965 to 1985 recording period at Twin Hills and is only rarely usually associated with thunderstorm activity.

4.2 Temperature

Temperature data for Twin Hills are given in Table 5. The three hottest months are November, December and January with a daily average maximum of 35.1°C for this period. High summer temperatures may be an impediment to crop performance. Skerman (1958) found that heat waves (three consecutive days with temperatures over 37.8°C) during flowering adversely affect grain sorghum yields. Although such data are not available, the average number of days with at least 38°C maximum temperature gives some indication of the probability of heat waves. Heat wave conditions may commence in October and extend through to March, although the most likely period is November to January (Table 5).

The three coldest months are June, July and August with an average daily minimum of 8.0°C for this period. The average number of days with < 2°C minimum temperature indicates the probability of frosts occurring. The likelihood of heavy frosts is represented by the average number of days with < 0°C minimum temperature. The frost period at Twin Hills extends from June to August with heavy frosts most likely in July (Table 5). The number and period of frosts may be slightly less for the Kilcummin area where elevation is 20 to 200 m above Twin Hills.

Table 5. Temperature data for Twin Hills

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Average Max. (°C)	34.7	33.4	32.7	30.8	27.0	24.2	24.1	26.7	29.8	32.8	35.2	35.4	30.6
Average Min. (°C)	22.2	21.8	19.8	16.0	11.9	7.9	6.8	9.3	12.0	16.1	19.5	21.3	15.4
Average days with -													
Max. ≥ 35 (°C)	17	10	7	1					1	7	17	18	
Max. ≥ 38 (°C)	6	2	1							1	5	7	
Min. < 2 (°C)						3	6	2					
Min. < 0 (°C)						1	2						

Source: Bureau of Meteorology

4.3 Humidity and evaporation

The average relative humidity and mean monthly pan evaporation at Twin Hills are given in Table 6. Relative humidity is much lower during the August to December period than for the remainder of the year. The combination of high temperatures and low relative humidity result in high evaporation rates and low effective rainfall.

Mean pan evaporation exceeds mean rainfall in all months throughout the year with the annual evaporation rate more than three times the annual rainfall.

Table 6. Average relative humidity and mean monthly pan evaporation for Twin Hills

		J	F	M	A	M	J	J	A	S	O	N	D	Annual
Relative humidity (%)	9 am	63	68	66	62	65	66	64	58	50	50	51	57	60
	3 pm	39	44	41	35	40	37	35	31	25	25	27	32	34
Monthly pan evaporation (mm)		233	184	186	150	112	90	96	133	183	245	255	270	2137

Source: Bureau of Meteorology

4.4 Wind

Apart from winds of thunderstorm origin, the area does not normally experience strong winds. Only two days with gale force winds and 23 days with strong winds were recorded at Twin Hills during the 1965 to 1985 period. Wind direction is predominantly south-east, with some northerly to easterly winds in summer and southerly winds in winter (Bureau of Meteorology 1962).

5. Geology and landform

The geology of the sample area was mapped at a scale of 1:250 000 by the Bureau of Mineral Resources and Geological Survey of Queensland between 1960 and 1963 (Veevers *et al.* 1964), with some areas re-examined during 1966 and 1967 (Olgers 1969, 1972). Malone (1966) and Galloway (1967a, 1967b,1967c) have also reported on the geology of the area.

During the Kilcummin land resource survey the geology of the sample area was observed in greater detail than in the previous studies and some variations with the original mapping were found. The updated information was incorporated into the Kilcummin land resource survey as part of the UMA mapping and data file. The UMA boundaries mapped at 1:100 000 can be considered as a refinement of the boundaries of the original geological units, but the UMA mapping is not comparable to a geologist's map of the same scale as detailed substrate investigations and mineralogy analyses were not undertaken.

5.1 Geological history

The stratigraphy, lithology, and landforms of the geological formations and their relationships with the soils of the Kilcummin area are summarised in Table 7.

The Pre-Devonian Anakie Metamorphics are the oldest known rocks in the area and form low steep hills. They form an extensive structural block, named the Anakie Inlier, which fringes the south-west corner of the Kilcummin area near Niagara. There is another small outcrop around Mt. McLaren. The rocks are principally mica-schist and slate but quartz reefs are also common.

During the Devonian period an unnamed sequence of intermediate volcanics was extruded over the metamorphics. Pyroclastic rocks are included in the sequence which outcrops over a very small area east of Mt. Saddleback. This sequence was included with the surrounding Peak Range Volcanics for the UMA mapping as the landform and soils are similar.

Towards the end of the Devonian, the Anakie Metamorphics and volcanic rocks were intruded by granite. Vast outpourings of acid and intermediate volcanics and pyroclastics of the Silver Hills Volcanics were probably associated with this intrusion. Exposed remnants of these outpourings form Mt. McLaren and the prominent low hills of Mt. Rankin and Mt. Violet. The granite is not exposed in the sample area. Subsequent erosion of this surface and deposition after the initial volcanic phase, laid down the mixed sediments of the Devonian-Carboniferous Mt. Rankin beds in low-lying areas. These areas were difficult to locate in the field and were included with nearby units of Silver Hills Volcanics and the Blenheim Subgroup as the associated soils were similar.

During the Permian, a thick series of sediments was laid down in the north-east of the area following regional subsidence known as the Bowen Basin downwarp. A sequence of calcareous sandstone, siltstone and coquinite (limestone) beds form the basal units of these sediments and outcrop over an extensive area south of the Mt. Lebanon homestead. The coquinite beds contain abundant fossilised shells of marine bivalves which flourished during this period. The bottom layer of coquinite has been named the Clarkei Bed after the characteristic fossil, *Strophalosia clarkei*, that it contains. During the Upper Permian this culminated in the deposition of over 500 m of mainly marine sediments (Blenheim Subgroup).

Table 7. The stratigraphy, lithology, and associated landforms and soils for the geological formations at Kilcummin

Geological age (million years B.P.)	Formation (Symbol[a])	Lithology	Stratigraphic relationships	Land forms	Associated soils
Pre-Devonian (>345)	Anakie Metamorphics (Pza)	Schist, slate, fine grained sandstone, quartz reefs	Oldest rocks	Rolling low hills	Violet
Late Devonian to Early Carboniferous (280-345)	Unnamed (Dn)	Andesitic flows, pyroclastics, some limestone lenses	Unconformable on Anakie Metamorphics	Very steep hills	Commissioner
	Silver Hills Volcanics (D/Cs)	Flow banded and spherulitic rhyolite, pyroclastics, minor arkose, lithic sandstone	Unconformable on Anakie Metamorphics, Retreat Granite and unnamed volcanics	Rolling low hills to gently undulating plains	Violet
	Mt Rankin Beds (D/Cr)	Felspathic lithic sandstone mudstone, quartzose sandstone, acid tuff	Disconformable on Silver Hills Volcanics	Undulating low hills to gently undulating rises	Violet; Heyford
Upper Permian (230-280)	Blenheim Subgroup (Pue)	Quartzose sandstone, siltstone, minor coal, sandy coquinite, ferruginised sandstone	Unconformable on Anakie Metamorphics, Silver Hills Volcanics, Mt Rankin Beds	Rolling low hills to gently undulating plains	Cherwell; Clarkei; Clarkei, clay surface variant; Heyford
Tertiary (1.8-65)	Peak Range Volcanics (Tp)	Trachyte, peralkaline rhyolite plugs, dykes and flows	Mainly intrudes Palaeozoic rocks, some flows	Very steep hills	Commissioner
	Unnamed (Tb)	Predominantly flow olivine basalt, red layered pyroclastic tuffs	Unconformable on an uneven surface of Palaeozoic rocks; bore logs suggests a number of flows	Rolling low hills to level plains	Cheeseboro; Russell; Russell, gilgai phase; Russell, stony phase; Falkner; Niagara; Kenlogan; Dickson; Dickson, shallow variant; Rankin
Late Tertiary to Early Quaternary (0.01-22.5)	Unnamed (Czm)	Magnesian limestone	Deposited in lakes, swamps,creeks; overlies Tertiary basalt	Gently undulating rises to level plains	Windradene; Yackadoo; Aroa

Table 7. (continued)

Geological age (million years B.P.)	Formation (Symbol[a])	Lithology	Stratigraphic relationships	Land forms	Associated soils
Late Tertiary to Early Quaternary (continued)	Unnamed (Czs)	Sand, sandy soil, ferruginised gravels, re-worked laterite	Underlain by lateritised rocks from Blenheim Subgroup	Gently undulating rises to level plains	Ok; Ok, gravel phase; Lebanon; Lebanon, red variant; Villafranca
	Unnamed (Cz and Czg)	Gravel and soil	Derived from Anakie Metamorphics, Silver Hills Volcanics	Gently undulating rises to level plains	Winvic; Apron
	Unnamed (Czb)	Heavy textured dark soil	Several stages of deposition evident; overlies unknown basement rocks	Elevated, level plains to undulating rises	Eleanor; Eleanor, mottled phase; Holding; Diamond; Diamond, footslope variant; Manar; Vicenza; Martyr; Kenmar; Kenmar, melonhole phase; Midden; Midden, melonhole phase; Well; Well, footslope variant;
				Low-lying, level plains	Well, sandy surface variant; Maraconda; Nungaroo
Quaternary (0-1.8)	Unnamed (Qa)	Alluvium, clay, sand, gravel		Alluvial plains	Moramana; Moramana, gilgai phase; Solferino; Jeffray; Cattle; Fletcher
				Valley flats	Miscellaneous soils

[a] These represent the symbols used in the 1:250 000 Geological Series of Queensland.

Since the Permian, the sedimentary rocks have been gently folded and subject to weathering and erosion. They remain today as the dissected low hills of the Cherwell Range and as adjacent gently undulating rises and plains between Ok (pronounced Okay) and Logan Creek homesteads.

In the Tertiary, extensive basalt flows were extruded in a trough between the Blenheim Subgroup in the east and the Anakie Inlier to the west. Today these flows blanket much of these older rocks as well as the Silver Hills Volcanics and form a continuous sheet south of Logan Creek. There are also basalt outliers east and north of Mt. Rankin and on Rugby and Mt. Lebanon properties. Bore hole data reveals the presence of sediments between some flows, indicating that at least two periods of extrusion occurred separated by an interval of erosion and deposition. The presence of small rounded rocky knolls, occasionally with vertical columns of basalt, are believed to represent the vents through which the basalt was extruded.

Two deposits of saponite, a pale coloured and magnesium rich clay, have been identified within the basalt landscape north of Mt. Rankin on the Moranbah-Blair Athol railway line. The saponite is believed to be a weathering product of volcanic ash and probably occurs elsewhere in the basalt landscape.

Another previously undescribed material can also be found within the basalt either as rock outcrop or as substrate at shallow depth below the soil cover. This material is red, massive, lightweight and has conchoidal fracture. A thin section indicates it is a lithic, crystal tuff (T. Macbeth personal communication). The tuff, formed from volcanic ash which has settled and consolidated, appears to be layered and occasionally deposited in water in the few pits where it is exposed. The tuff has a groundmass of devitrified glass containing phenocrysts of quartz, plagioclase, biotite and chlorite. There are insufficient exposures to determine the relationship of the tuff with the basalt and it may correlate with either Tertiary or earlier Devonian volcanic activity.

The basalt landscape consists mainly of gently undulating plains and dominates the southern part of the Kilcummin area as far north as Logan Creek.

Shallow acid intrusions and minor flows occur near Mt. Saddleback and Red Riding Hood. These rocks comprise the Tertiary Peak Range Volcanics and form picturesque volcanic plugs, domes and dykes of the Peak Range. The relationships of these rocks to the Tertiary basalt is not clear but they probably all belong to one volcanic phase and are derived from one primary magma.

Following the basalt flows magnesium limestone was deposited in lakes, swamps and streams filled with calcium and magnesium rich waters draining out of the basalt landscape. Erosion of the surrounding basalt exposed the limestone in many places. At Yackadoo, the limestone is covered by a shallow deposit of alluvial quartz gravel, probably derived from outwash off the Anakie Metamorphics.

Galloway (1967c) has reconstructed the probable process of landscape development that followed the phase of basalt extrusion. A prolonged period of erosion occurred in mid-Tertiary times. Initially, the rivers removed the products of weathering and erosion completely and the overall surface was substantially lowered. A period then followed in which the eroded debris was no longer exported afar but largely accumulated on the lowlands as sediments. The result was an extensive, gently undulating Tertiary land surface, which became deeply weathered. It is not clear whether this deep weathering preceded, accompanied or followed the completion of the land surface.

During formation of the Tertiary land surface the finer sediments were carried further than the coarser ones and consequently formed vast clay sheets. Deep weathering of these clay sheets

produced the strongly and coarsely mottled, saline and acid Tertiary clays. The mottle colours include blue-grey, red-orange and yellow. The salts probably originated from lateritised parent materials before denudation (Gunn 1966, Gunn and Richardson 1979). At Kilcummin, the Tertiary clays form the substrate for extensive level plains north-west of the basalt landscape. Deep drilling during this study encountered sand lenses in this material at 4.5 to 5.0 m depth. Local graziers have also noted the occurrence of 'beach sand' layers within the clays while excavating dams. The sand layer is not mentioned in the few other bore logs from this area (Veevers *et al.* 1964) and may represent either former isolated stream beds or dune deposits around an ancestral lake shore.

According to Galloway (1967c), late Tertiary (or possibly early Quaternary) erosion resulted in extensive clay fans being deposited over the Tertiary clays in the Manar to Wentworth area by streams incising into the weathered basalt further south. The fans are elevated 10 to 40 m above the extensive level plains overlying Tertiary clays. However, the mottling, salinity and acid pH that characterise the Tertiary clays beneath the lower-lying level plains also occur at a similar depth below the surface of the elevated fans. These subsurface features may simply be the result of particular soil forming processes that have occurred on all deep clays in the region, rather than representing a distinct geological layer, the Tertiary clays, as suggested by Galloway (1967c).

The fan deposits contain distinct layers of grey and red clay, weathered basalt and a cemented gravelly band. On a broad crest at Diamond Downs, the grey clay overlies a band of coarser weathered basalt at 1.5 m depth. The weathered basalt then overlies red clay at 2.0 m which continues to 4.5 m where another layer of weathered basalt is encountered. This sequence of grey clay over weathered basalt and/or red clay is common throughout this area. The grey clay is at the surface of crests and most slopes. However, on some slopes the red clay is exposed while in other areas the two layers are intricately mixed with the red clay occurring on mounds and the grey clay in depressions of linear and lattice gilgai.

As well as the weathered basalt, a cemented layer of gravel and sandy clay can occur at depth within the red clay. It contains fine gravel and sand composed of metamorphic rock fragments and occasional pieces of basalt, cemented by calcareous materials. Gravel pits on Diamond Downs and Eleanor Plains indicate that the thickness of this distinctive layer is quite variable. The presence of both gravel and clay layers indicates that deposition occurred in a number of different evolutionary stages. The grey clay is probably derived from less weathered basalt in the west but a noticeable increase in sand content towards the east indicates a mixed source of basalt and Permian sediments. Further south, the higher level alluvium adjacent to Brown Creek is probably of the same age because of the similar nature of cemented material encountered at depth.

The fan deposits are similar to the lower-lying Tertiary clays in being saline at depth. However, they are predominantly alkaline although the red clay may become acid at depth. It is possible that the fans once covered more of the lower-lying level plains than at present and are receding due to erosion. Another elevated area of clay plains has been located immediately north of the sheet area at Wyena and may represent an isolated fan remnant.

The fans form gently undulating rises, gently undulating plains and level plains.

The clay sheets comprised only a small part of the Tertiary land surface and in the other areas deep laterite profiles consisting of an iron rich zone over mottled and pallid zones developed during the late Tertiary (Galloway 1967c). Much of this lateritic material was subsequently eroded and stripped during the late Tertiary. In the Ok, Mt. Lebanon and Rugby areas, the erosion products accumulated as Cainozoic ferruginised deposits of soil material, sand and cemented gravel. Exposed profiles of this material occur five kilometres west of Mt. Lebanon homestead and in cuttings on the

Blair Athol to Moranbah railway line. The landforms are principally level to gently undulating plains.

During the late Tertiary, gravel and unconsolidated material were also deposited around Mt. McLaren and the eastern margin of the Anakie Inlier near Niagara and Yackadoo. The quartz reefs within the Anakie Metamorphics are the major source for the gravel although the Silver Hills Volcanics probably contributed to the deposition at Mt. McLaren as well. The existing landforms are gently undulating rises to level plains.

During the Quaternary, streams deposited large amounts of sediments forming extensive alluvial plains throughout the area. The nature of the alluvia is determined by the geological units from which they are derived.

5.2 Landform

The landforms of the area are described in Table 8 using the terminology of Speight (1984). The modal slope class (level, gently undulating, undulating, rolling and very steep) indicates the general slope range for each landform but landforms in the same class can have quite different slopes. The mean slope and slope range given in Table 8 are based on actual slopes recorded at field inspection sites during the study.

Table 8. The landforms and recorded slopes of Kilcummin

Landform pattern	Relief/modal slope class	Mean slope (%)	Slope range (%)	Area (ha)
Hills	Very steep hills	none recorded		2 630
Low hills	Rolling low hills	5.2	0-30	16 290
	Undulating low hills			8 690
Plateaus		none recorded		480
Rises	Undulating rises	5.5	0-23	2 850
	Gently undulating rises	1.3	0-4	14 530
Plains	Gently undulating plains	0.8	0-3	110 780
	Level plains	0.1	0-1.5	93 370
Alluvial plains	Gently undulating plains	<0.1	0-2	1 920
	Level plains			33 690

Plains are the most common landform pattern, accounting for 84.1% of the sample area. Approximately 32% of the sample area can be described as stagnant alluvial plains and relict alluvial fans which have unconsolidated sediments as substrate material. Deposition of sediments by overbank stream flow has ceased on these landforms and erosion by overland flow is now the principal process of landscape development. Alluvial plains, in which over-bank flooding by streams is still active to some extent, represent a further 12.5% of the area. The remaining plains are associated with either basalt and other volcanic rocks (30.7%), magnesian limestone (5.1%) or the Permian sedimentary rocks of the Blenheim Subgroup (3.7%).

The alluvial plains have an extremely low gradient with even the gently undulating forms having recorded slopes only slightly above 1%. The mean slope value for all alluvial plains is substantially lower than the mean for the remaining plains on hard rocks, relict alluvial fans and stagnant alluvial plains. However, these other plains also have quite low slopes with mean values less than 1% for both the level and gently undulating forms.

The rises represent only 6.1% of the area. The majority are associated with basalt and other volcanic rocks, magnesian limestone, the Permian sedimentary rocks or Anakie Metamorphics. The remainder are associated with various outwash deposits from these hard rocks or represent the more undulating margins of the relict alluvial fans. Although the gently undulating rises have a similar slope range to the gently undulating plains they have a higher mean slope.

Low hills and hills represent 9.6% of the area. The hills are associated with the volcanic rocks that form part of the Peak Range. The low hills occur on the Silver Hills Volcanics and Permian sedimentary rocks with minor areas on basalt. They appear to have similar slopes to the undulating rises but the inspection sites for the low hills are mainly on the more accessible, lower sloping areas. There were no slopes recorded on the hills and their relief/modal slope class was determined by airphoto interpretation.

Very small areas (0.2%) of plateaus occur in the north-east of the area on Permian sedimentary rocks. The few sites on the plateaus varied from 0% slopes on the surface to 13% on the surrounding scarps.

6. Hydrology

6.1 Surface water

Drainage in the Kilcummin sheet is predominantly north-west through Diamond, Logan and Brown Creeks and their tributaries. These streams flow into the Suttor River beyond the sample area, forming part of the Burdekin River system. The south-western corner drains into Miclere Creek and eventually into the Belyando River, also forming part of the Burdekin River system. The eastern margin of the sample area is drained by Grosvenor Creek and other smaller streams which flow north to north-easterly into the Isaac River which in turn, drains to the Fitzroy River. The catchment divide is the Denham Range which is barely discernible in the sample area.

All streams are intermittent. Runoff follows rainfall distribution closely with a strong concentration in the months January-April and very small runoff in most of the remaining months (Irrigation and Water Supply Commission of Queensland 1965). Apart from the wide seasonal variation flows also vary considerably from year to year. Below average flows may persist for many years but very heavy flooding also occurs on rare occasions.

6.2 Groundwater

Groundwater is used for stock and domestic purposes in the sample area. Water with up to 9 000 mg/L of Total Dissolved Ions (TDI) is considered suitable for beef cattle although 10 000 mg/L can be tolerated for limited periods (Gill 1984). The upper limit for suitable domestic water is 1 000 mg/L TDI although levels up to 1 500 mg/L can be used for short periods (Ishaq 1985). These total salinity levels are acceptable provided harmful specific ions or salts are also within acceptable levels for each purpose.

There is only a small amount of data available for groundwater in the sample area (Veevers *et al.* 1964) but Ishaq (1985) has discussed the hydrogeology of several formations that occur in Kilcummin while investigating a number of map sheets to the south. A summary of this information is given in Table 9. The figures listed in the table for Total Dissolved Solids approximate TDI values, assuming that dissolved silica is negligible.

Water quality from Quaternary alluvium is generally good for both domestic and stock purposes and is at relatively shallow depths. However, Ishaq (1985) records 35 dry bores out of a total 95 bores known to be drilled in this substrate. Water supply and quality are variable in the Cainozoic unconsolidated sediments. Few successful bores have been obtained in the extensive clay sheets (Czb) and yields are mainly low. The Cainozoic gravel and soil (Czg) have been mainly deposited from the Anakie Metamorphics and generally contain good quality water at shallow depth but yield is quite low. Ishaq (1985) did not record a dry bore in this unit.

Table 9. Groundwater data for some geological formations occurring at Kilcummin

	Within Kilcummin sample area[a]			From adjacent southern areas[b]		
Geological formation	Depth of aquifer (m)	Yield (m^3/day)	Water quality comments	Depth of aquifer (m)	Yield (m^3/day)	Total Dissolved Solids (mg/L)
Quaternary alluvium				6-37	15-2 000	210- 5 500
Cainozoic clay sheets[c] (Czg)				2-35	1-650	60- 1 400
Cainozoic gravel and soil[c] (Czb)	17-101	20-70	varies from good for all purposes to unsuitable for stock			
Tertiary basalt	9-69	30-200	good for all purposes	6-95	3-950	230- 6 000
Permian sandstones[d]	63-77	60	good for stock	10-100	10-270	3 700-11 000
Silver Hills Volcanics				6-65	20-120	700- 1 000
Anakie Metamorphics				6-130	5-500	330-15 000

[a] Source: Veevers *et al.* (1964)
[b] Source: Ishaq (1985)
[c] These units are described in section 5.1 and Table 7.
[d] The Blenheim Subgroup forms part of this unit.

Groundwater is also stored and transmitted through the joints and fractures of otherwise relatively impermeable, fractured rocks (Ishaq 1985). The basalts are the best sources within the fractured rocks supplying good quality water at relatively shallow depth but few bores maintain supply (Veevers *et al.* 1964). Yields are generally low compared with bores tapping into the extremely vesicular basalt of the Emerald-Springsure area and many dry bores are encountered (Pearce 1969). Supply from the Permian sandstones is low to moderate (20 to 450 m^3/day) and water quality is generally suitable for stock. The limited data for the Silver Hills Volcanics suggests the water quality is very good to good but yield is low to moderate. The Anakie Metamorphics contribute significant supplies of water but quality is extremely variable (Ishaq 1985).

7. Vegetation

The vegetation of the Kilcummin area has been previously described by Pedley (1967) and Story (1967) as part of the CSIRO land systems surveys. A number of plant communities were identified during this study and are described on the basis of the major plant species present and the structural formation (growth form, height and crown separation) of the dominant stratum (according to Walker and Hopkins 1984).

7.1 Plant communities

The major plant communities of the Kilcummin area are summarised in Table 10 and are related to each soil profile class in Table 12. The scientific names for the plants mentioned in the report are given in Appendix IV. A number of structural formations were identified, ranging from closed forest to tussock grassland:

7.1.1 Open to closed forests

The open to closed forests are dominated by acacia species. Walker and Hopkins (1984) used the term 'forest' to describe these communities, however the locally applied term 'scrub' is used in this report.

The gidgee and brigalow scrub communities may be dominated by either gidgee or brigalow alone, or by a mixture of both. A number of species are commonly associated including yellowwood, bauhinia, Queensland bottletree, wilga, false sandalwood and broom bush. Occasionally, emergents of either yapunyah, Dawson gum or brigalow may be present above the dominant stratum. These communities occur on a range of clays, loams and duplex soils, with variable depth, parent material, gilgai development and chemical properties. In melonhole gilgai country (vertical interval between mounds and depressions $>$ 0.3 m), the tree and shrub species are generally confined to the margins of mounds. Scrub dominated by gidgee alone is best developed on the red to red-brown cracking clays and is floristically simpler than the mixed gidgee and brigalow scrub occurring predominantly on the grey clays. The ground layer contains currant bush and sparse native pastures including brigalow grass, slender panic, hooky grass, slender chloris and fairy grass.

A sharp transition occurs between the brigalow and gidgee scrub communities and tussock grasslands within the basalt landscape but there is a more gradual transition on similar clays derived from Cainozoic sediments. In the basalt landscape, it appears that bluegrass has a number of mechanisms enabling it to readily colonise strongly self-mulching, cracking clays compared with gidgee and brigalow which are restricted to the finer self-mulching, lighter clay soils (Gunn 1974, Jacobsen 1981).

Boree scrub occurs on extensive alluvial clay plains around Diamond Downs and forms a transition between gidgee-brigalow scrub and tussock grasslands. Its most common associates are coolibah and yellowwood. The ground layer appears to be mainly Queensland bluegrass pastures (described in 7.1.3).

Lancewood scrub is located on shallow rocky soils developed on Permian sedimentary rocks. Bendee is commonly associated and a poplar box open woodland to woodland (described in 7.1.2) is also intermixed with this community. The ground layer is extremely sparse and contains mainly wiregrasses and *Cleistochoa subjuncea*.

Table 10. A description of the plant communities

Dominant plant species	Structural formation	Other common species
Gidgee	Mid-high to tall, open to closed forest	Bauhinia, yellowwood, bottletree, emu apple, wilga, boonaree, false sandalwood, a turkey bush, currant bush and peachbush
Gidgee-brigalow	Mid-high to tall, open to closed forest	Yellowwood, boree, true sandalwood, whitewood, scrub leopardwood, wilga, bauhinia, narrow leaf bumble-tree, scrub boonaree, cumby cumby, myrtle tree, currant bush, peachbush, limebush, broom bush, a turkey bush, wallaby apple, and nipan
Brigalow	Mid-high to tall open forest	Bauhinia, yellowwood, wilga, false sandalwood, currant bush and broom bush
Boree	Mid-high to tall, woodland to open forest	Coolibah, yellowwood, gidgee, brigalow, gooramurra, emu apple, limebush and broom bush
Lancewood	Mid-high to low, open to closed forest	Bendee, Queensland grey ironbark, yellow jacket, lemon scented gum, rosewood, black wattle, Bancroft's wattle, *Acacia curvinervia*, tea tree, a turkey bush, a geebung and medicine bush
Gum topped bloodwood	Tall to mid-high, open woodland to woodland	Mountain coolibah, sally wattle, Moreton Bay ash, ironwood, bauhinia, gundabluie and yellowwood
Inland bloodwood	Tall to mid-high, open woodland to woodland	Whitewood, mountain coolibah, gum topped bloodwood and ghost gum
Mountain coolibah	Tall, open woodland to woodland	Gum topped bloodwood, yellowwood, bauhinia, inland bloodwood, broad leaved bottletree, sally wattle and a turkey bush
Reid River box	Tall, open woodland to woodland	Bauhinia, false sandalwood, yellowwood, dead finish and brigalow

Table 10. (continued)

Dominant plant species	Structural formation	Other common species
Silver leaved ironbark	Tall, open woodland to woodland	Gum topped bloodwood, mountain coolibah and Leichhardt bean
Coolibah	Tall, open woodland to woodland	Boree, brigalow, gooramurra and black tea tree
Yapunyah	Very tall to tall, open woodland to woodland	Brigalow, gidgee, lancewood, a turkey bush and currant bush
Dawson gum	Tall to very tall, open woodland to woodland	Brigalow, poplar box, whitewood, wilga, false sandalwood, a turkey bush, limebush, broom bush and nipan
Narrow leaved ironbark	Tall, open woodland to woodland	Poplar box, ghost gum, long fruited bloodwood, quinine berry, a turkey bush and *Albizia canescens*
Queensland grey ironbark	Tall, open woodland to woodland	Ghost gum, long fruited bloodwood, poplar box, kurrajong, wattles, quinine berry, Leichhardt bean, red ash and prickly pine
Poplar box	Tall, open woodland to woodland	Long fruited bloodwood, narrow leaved ironbark, ghost gum, Moreton Bay ash, vine tree, wattles, false sandalwood, red ash, Leichhardt bean, wilga, a turkey bush and nipan
Dead finish	Mid-high, woodland to open woodland	Dead finish, bauhinia, false sandalwood, broad leaved bottletree, vine tree, yellowwood, a turkey bush and currant bush
Queensland bluegrass	Tall to mid-high, tussock grassland	Other bluegrasses, yabila grass, native millet, coolibah grass, a few wiregrasses, flinders grasses, and gundabluie, sally wattle and mimosa bush
Queensland bluegrass-mitchell grass	Tall to mid-high, tussock to open tussock grassland	Other bluegrasses, yabila grass, native millet, coolibah grass, a few wiregrasses, flinders grasses and brigalow

7.1.2 Open woodlands to woodlands

A range of eucalypt species dominate extensive open woodlands and woodlands within the area. The communities vary considerably in floristics, tree density and range of native grasses associated.

Gum topped bloodwood and inland bloodwood communities occupy similar clay soils developed on basalt, limestone and alluvium from these materials. The most common associated trees are mountain coolibah, Moreton Bay ash, sally wattle, whitewood and ironwood. There is a sparse shrub layer of mainly sally wattle, gundabluie, yellowwood, and whitewood. The ground layer consists of Queensland bluegrass pastures with a prominent black speargrass component on the shallower soils. These communities form characteristic belts through the tussock grasslands.

A mountain coolibah community also occurs on these soils as well as on shallow soils developed on calcareous greywacke. The most common associated trees are gum topped bloodwood and inland bloodwood. The shrub layer is only sporadic and includes mainly sally wattle and a turkey bush. This community also occupies small areas of red duplex soils where prickly pine becomes a common associate. The ground layer is mainly Queensland bluegrass pastures on the clay soils but wiregrass-bluegrass pastures on the other soils. The wiregrass-bluegrass pastures include desert bluegrass, pitted bluegrass wiregrasses, barbed wire grass, kangaroo grass, curly windmill grass and lovegrasses.

The Reid River box community occurs only on light, non-cracking clays developed on deeply weathered basalt. Bauhinia, false sandalwood and yellowwood are the most common associates. A silver leaved ironbark community is also found on isolated areas of the shallow clays developed on basalt. The ground layer for both communities is Queensland bluegrass pastures mainly with a prominent component of black speargrass on the shallow soils.

A coolibah community with a sparse shrub layer occurs extensively on flooded alluvial plains and local runon areas. The soils are predominantly cracking clays but small areas of duplex soils and non-cracking clays on alluvium are included. Boree and brigalow are the most common tree and shrub associates. The ground layer consists mainly of Queensland bluegrass and Queensland bluegrass-mitchell grass pastures.

The yapunyah community covers small areas of shallow, gravelly sands and loams on rolling low hills and cracking clays on eroding footslopes of the Cainozoic alluvial fans. A Dawson gum community also occupies small areas of shallow gravelly loams and clays developed on Cainozoic gravel. The yapunyah community has gidgee, brigalow, false sandalwood and currant bush associated whereas the Dawson gum community has the same associated species except for gidgee. The ground layer is very sparse in both communities and comprises similar grasses to the brigalow and gidgee scrub communities.

The narrow leaved ironbark community occurs only on shallow gravelly loams and the Queensland grey ironbark community is restricted to red earths. Both communities have long fruited bloodwood, ghost gum and poplar box as common associates. The narrow leaved ironbark community has quinine berry and a turkey bush in the sporadic shrub layer but the Queensland grey ironbark community also has a wide range of wattles and other species associated.

The poplar box community is restricted to the texture contrast soils and shallow rocky soils in the north-east. It has a very wide range of associated species. The ground layer in all three communities consists of wiregrass-bluegrass pastures.

Small areas of the shallow clay soils on limestone are occupied by a community dominated by dead finish with a range of other species associated. The ground layer consists mainly of Queensland bluegrass pastures with a prominent black speargrass component.

7.1.3 Tussock grasslands

Two tussock grasslands or 'downs' were identified, namely, Queensland bluegrass and Queensland bluegrass with a substantial component of mitchell grasses.

Historically, the Queensland bluegrass 'downs' were dominated by a number of highly productive bluegrasses but the unpalatable yabila and wiregrasses have invaded due to excessive burning and overgrazing. This community of mixed grasses dominates the clay soils developed on basalt and the clays on Cainozoic alluvial fans.

The Queensland bluegrass-mitchell grass community occupies the level plains with cracking clays derived from deeply weathered material. Mitchell grasses form a substantial component of this community although species composition can fluctuate with changes in either climate or grazing pressure (Pedley 1967). Stunted brigalow occurs in very shallow depressions in the Well Plains area, and is a common associate of the grassland.

7.2 Weeds and poisonous plants

A number of common weeds, particularly in cultivated areas, and plants suspected of being poisonous to stock were identified during the survey (Table 11). Problem weeds and their susceptibility to herbicides have been discussed by Hamilton *et al.* (1985).

Table 11. Common weeds and suspected poisonous plants

Plant	Weed	Suspected poisonous plant
Bellvine	X	
Bitter bark	X	X
Boggabri	X	
Couch grass	X	
Cowvine	X	
Ellangowan poison bush		X
Fuschia bush		X
Mexican poppy	X	
Native jute	X	
Noogoora burr	X	X
Parthenium	X	
Peak Downs curse	X	
Pimelea		X
Potato weed	X	
Raspweed	X	
Rattlepod	X	
Thornapple	X	
Wild rosella	X	
Teucry weed	X	
Yellowwood		X

Parthenium has become a major problem in the area since its introduction in the 1970's. It is a rapid coloniser of disturbed and degraded areas and is expensive and difficult to eradicate. A parthenium survey (R.J.Tucker, unpublished data) identified soils with, or once having, scrub as at most risk to infestation.

8. Soils

The soils have been previously investigated in a number of broad scale surveys by Isbell (1962), Gunn (1967a,1967b), Isbell and Hubble (1967) and Isbell *et al.* (1967). The mapping scales varied between 1:1 000 000 to 1:2 000 000.

In this study 35 soil profile classes, seven phases and six variants were identified. A soil profile class is a group of similar profiles with the variation in some features being less within the class than between classes (adapted from Isbell 1988). A soil phase is a subdivision of the soil profile class based on attributes that have particular significance for land use (Isbell 1988). For example, a group of very stony profiles of a mainly stone free soil can be defined as a stony phase of that soil. A variant is a soil with one or more profile attributes clearly outside the range of any defined soil profile class but occupies such a restricted area that it is not defined as a separate soil profile class (adapted from Isbell 1988). For example, small occurrences of a red duplex soil can be described as a variant of a more widespread yellow duplex soil.

8.1 Description of the soil profile classes

A summary description of the soils is given in Table 12. The terminology used to describe the soils are explained in Appendix I and each soil profile class is described in greater detail in Appendix II.

The soil profile classes have been grouped into landscape units which contain similar substrate material and have similar topography. The landscape units provide both a broad scale break-up of the study area and the structure for presentation of soils information:

8.1.1 Soils overlying Devonian-Carboniferous acid volcanic and minor sedimentary rocks

The shallow and stony **Violet** soil occurs on low hills and gently undulating rises between Mt. Violet, Mt. McLaren and the Peak Downs Highway. **Violet** overlies principally acid volcanic rocks but small areas of Pre-Devonian Anakie Metamorphics are included. The gravelly but deeper **Apron** soil occurs downslope at Mt. McLaren and Mt. Rankin on unconsolidated sediments that were probably derived from the rocks under **Violet**. Elsewhere, the hills and rises with **Violet** are generally surrounded by a variety of unrelated substrate materials and soils.

8.1.2 Soils overlying Permian sedimentary rocks

The dissected Cherwell Range in the north-east corner of the study area is dominated by the very rocky and gravelly, shallow **Cherwell** soil. The range has a characteristic vegetation of lancewood scrub with pockets of poplar box open woodland to woodland.

The poplar box open woodland to woodland also occurs on the lower and less dissected, southern and western margins of Cherwell Range. The hard setting duplex soil, **Heyford**, occupies these gently undulating areas where they are formed on the Permian sedimentary rocks as well as on minor outcrops of sedimentary rocks of the Devonian-Carboniferous Mt. Rankin Beds.

Table 12. The major attributes, classification and vegetation of the soils

Soil	Major attributes[1]	Great soil group[2]	Main principal profile forms[3,4]	Predominant natural vegetation
Soils overlying Devonian-Carboniferous acid volcanic and minor sedimentary rocks:				
- Undulating low hills to gently undulating rises				
Violet	A cobbly, hard setting, red-brown to dark, loamy sand to sandy clay with neutral reaction trend overlying rock or gravel by 300 mm depth	Lithosol	Uc1.23, Um1.21, Uf1.43, Um1.43, Uc1.21	Narrow leaved ironbark, tall to mid-high or yapunyah, very tall to tall, open woodland to woodland
Soils overlying Permian sedimentary rocks:				
- Rolling low hills, undulating rises and plateau remnants				
Cherwell	A very rocky and gravelly, red-brown to dark, sand to sandy clay loam with acid to neutral reaction trend overlying sandstone by 600 mm depth	Lithosol	Uc1.23, Uc1.21, Um1.23, Uc1.24	Lancewood, mid-high to tall, open to closed forest
Clarkei	A gravelly, hard setting, red-brown to brown, sandy loam to clay loam, sandy surface soil either overlying an alkaline red-brown to brown (sandy) clay subsoil or directly overlying sandstone	No suitable group	Dr2.12, Um1.13, Dr2.13, Dy2.13, Dy2.12, Uc1.13	Mountain coolibah, tall, open woodland to woodland
Clarkei, clay surface variant	A stony, hard setting, brown to red-brown clay with alkaline reaction trend overlying sedimentary rocks by 450 mm depth	No suitable group	Uf6.31	Brigalow, tall to mid-high, open forest
- Gently undulating plains and rises				
Heyford	A duplex soil with sandstone gravel and hard setting, dark to red-brown, loamy sand to sandy clay loam surface and bleached subsurface over an alkaline, mottled grey, yellow and red-brown clay subsoil overlying sandstone	Solodic - solodized solonetz	Dy3.43, Dy3.33	Poplar box, tall, open woodland to woodland

Table 12. (continued)

Soil	Major attributes[1]	Great soil group[2]	Main principal profile forms[3,4]	Predominant natural vegetation
Soils overlying Tertiary volcanic and pyroclastic rocks:				
- Very steep hills to gently undulating rises				
Commissioner	A very rocky and stony, hard setting, dark, loamy sand to sandy clay loam with acid reaction trend overlying acid to intermediate volcanic rocks by 300 mm depth	Lithosol	Um1.44, Uc1.44, Uc1.24	Narrow leaved ironbark, tall to mid-high, or mountain coolibah, tall, open woodland to woodland
- Rolling low hills to level plains				
Cheeseboro	A stony, self-mulching to hard setting, dark to red-brown clay with neutral to alkaline reaction trend overlying basalt by 400 mm depth	No suitable group and black earth	Uf6.32, Uf6.33, Ug5.12, Uf6.31	Mountain coolibah, tall, or gum topped bloodwood, tall to mid-high, open woodland to woodland or Queensland bluegrass, tall, tussock to open tussock grassland
- Level plains to gently undulating rises				
Russell	A self-mulching, grey-brown to red-brown, cracking clay with alkaline reaction trend overlying basalt from 400 mm depth	Grey, brown and red clay	Ug5.22, Ug5.32, Ug5.37	Queensland bluegrass, tall, tussock to open tussock grassland or gum topped bloodwood, tall to mid-high, or mountain coolibah, tall, open woodland to woodland
Russell, gilgai phase	A linear and lattice gilgai, self-mulching, red-brown to grey-brown, cracking clay with alkaline reaction trend overlying basalt from 800 mm depth	Grey, brown and red clay	Ug5.37, Ug5.22, Ug5.38, Ug5.25	Gum topped bloodwood, tall to mid-high, open woodland to woodland or Queensland bluegrass, tall, tussock to open tussock grassland
Russell, stony phase	Similar to Russell except for the presence of common to abundant cobble and stone on the surface			

Table 12. (continued)

Soil	Major attributes[1]	Great soil group[2]	Main principal profile forms[3,4]	Predominant natural vegetation
Falkner	A coarse self-mulching, grey-brown to dark, cracking clay with alkaline to neutral reaction trend overlying basalt from 500 mm depth	Grey clay and black earth	Ug5.22, Ug5.12	Queensland bluegrass, tall, tussock to open tussock grassland
Niagara	A very fine self-mulching, red to brown, cracking clay with alkaline reaction trend overlying basalt from 900 mm depth	Red and brown clay	Ug5.37, Ug5.38, Ug5.32, Ug5.34	Gidgee and brigalow, tall to mid-high, open forest to woodland
Rankin	A very fine self-mulching, grey to grey-brown, cracking clay with alkaline reaction trend overlying mottled, light grey and light yellow orange clay from 900 mm depth	Grey clay	Ug5.22, Ug5.27	Completely cleared and cultivated; formerly gidgee and brigalow, tall to mid-high, open forest to woodland
Dickson	A firm to hard setting, red clay with neutral to alkaline reaction trend overlying basalt from 600 mm depth	No suitable group	Uf6.31	Reid River box, tall to open woodland to woodland or gidgee and brigalow, tall to mid-high, open forest to woodland
Dickson, shallow variant	A gravelly, hard setting to very fine self-mulching, red clay with acid to alkaline reaction trend overlying ferruginised gravel or red tuff by 400 mm depth	No suitable group	Uf6.31, Uf6.53	Brigalow and gidgee, tall to mid-high, open forest to woodland
Kenlogan	A self-mulching, red to red-brown, mainly cracking clay with neutral to alkaline reaction trend overlying red tuff from 450 mm depth	Red clay and no suitable group	Ug5.37, Uf6.31	Brigalow, tall to mid-high, open forest to open woodland or Queensland bluegrass, tall, tussock to open tussock grassland

Table 12. (continued)

Soil	Major attributes[1]	Great soil group[2]	Main principal profile forms[3,4]	Predominant natural vegetation
Soils overlying Cainozoic limestone:				
- Gently undulating rises to level plains				
Windradene	A very fine self-mulching to firm, and occasionally cracking, dark to red, clay and clay loam with alkaline reaction trend overlying limestone by 400 mm depth	Rendzina and terra rossa soil	Uf6.31, Uf6.32, Uf6.33, Ug5.31, Ug5.36, Um6.41	Dead finish, mid-high to tall, woodland to open woodland or gidgee and brigalow, tall to mid-high, open forest to woodland or mountain coolibah or bloodwood, tall to mid-high, open woodland to woodland
Yackadoo	A gravelly, hard setting to firm, red-brown, clay and clay loam with neutral to alkaline reaction trend overlying soft and limestone with quartz gravel by 300 mm depth	Terra rossa soil	Uf6.53, Um5.11, Uf6.31	Gidgee and brigalow, tall to mid-high, open forest to woodland
Aroa	A lattice and linear gilgai complex overlying limestone and calcareous marl below 600 mm depth			
	Mounds: self-mulching, red-brown to grey-brown, mainly cracking clay with alkaline reaction trend	Red and brown clay and no suitable group	Ug5.37, Ug5.25 Ug5.32, Uf6.31, Uf6.33, Ug5.24	Mountain coolibah, tall, or gum topped bloodwood, tall to mid-high, open woodland to woodland
	Depressions: self-mulching, grey-brown to dark, cracking clay with alkaline reaction trend	Grey clay and black earth	Ug5.22, Ug5.21, Ug5.12, Ug5.11, Ug5.25, Ug5.13	

Table 12. (continued)

Soil	Major attributes[1]	Great soil group[2]	Main principal profile forms[3,4]	Predominant natural vegetation
Soil overlying Cainozoic ferricrete and weathered sediments:				
- Level to gently undulating plains				
Lebanon	A duplex soil with ferruginised gravel and hard setting, dark to brown, loamy sand to sandy clay loam surface, usually with a bleached subsurface, over a generally mottled grey-brown, yellow-brown and red clay subsoil with neutral to alkaline reaction trend overlying ferricrete	Solodic-solodized solonetz and no suitable group	Dy3.33, Dy3.32, Dy3.43, Dy3.42, Dy2.43, Dy2.12	Poplar box, tall open woodland to woodland
Lebanon, red variant	A duplex soil with hard setting, red, light sandy clay loam to clay loam, sandy surface, occasional pale subsurface, over red clay subsoil with neutral to alkaline reaction trend overlying ferricrete	Red-brown earth and non-calcic brown soil	Dr2.13, Dr2.12, Dr2.23, Dr2.22	Mountain coolibah, tall, open woodland to woodland
Villafranca	A hard setting, red, massive, gradational soil with acid to neutral reaction trend overlying ferricrete	Red earth	Gn2.11, Gn2.12, Um5.52	Queensland grey ironbark, tall to mid-high, open woodland to woodland
- Gently undulating plains and rises				
Ok	A hard setting, red to grey-brown clay with alkaline to neutral reaction trend overlying ferricrete and weathered clay from 500 mm depth	No suitable group	Uf6.31, Uf6.33, Uf6.34	Gidgee and brigalow, tall to mid-high, open forest to woodland
Ok, gravel phase	A gravelly, hard setting, red to red-brown, clay and gradational soil with neutral reaction trend overlying ferricrete and weathered clay from 200 mm depth	No suitable group	Uf6, Uf6.31, Gn3.12	Gidgee and brigalow, tall to mid-high, open forest to woodland

Table 12. (continued)

Soil	Major attributes[1]	Great soil group[2]	Main principal profile forms[3,4]	Predominant natural vegetation
Soils overlying Cainozoic gravelly sediments:				
- Gently undulating rises to level plains				
Winvic	A gravelly, hard setting red to red-brown, clay loam, clay or duplex soil with neutral to alkaline reaction trend overlying quartz gravel by 500 mm depth	No suitable group	Um5.21, Uf6.31, Dr2.12	Dawson gum, tall to very tall, woodland to open woodland
Apron	A gravelly, hard setting, red to grey-brown, clay, clay loam, gradational soil or duplex soil with neutral to alkaline reaction trend overlying quartz gravel and buried layers by 1100 mm depth	No suitable group	Uf6.31, Gn3.12, Um3, Db1.42, Um5.51	Brigalow, tall to mid-high, open forest to open woodland
Soils overlying Cainozoic clay sediments:				
- Elevated, level plains to undulating rises				
Eleanor	An occasionally normal, linear or lattice gilgai, self-mulching, grey-brown to grey, cracking clay with neutral to alkaline reaction trend overlying sand and unconsolidated buried clay, gravel	Grey clay	Ug5.24, Ug5.25, Ug5.29	Queensland bluegrass, tall, tussock to open tussock grassland or coolibah or inland bloodwood, tall to mid-high, open woodland
Eleanor, mottled phase	Similar to Eleanor except for the following: - a more frequent occurrence of dark colours in the surface soil and upper part of the subsoil; - the presence of a strongly and coarsely mottled, acid, gleyed clay (which may be alkaline in the upper part) from 1200 mm depth			

Table 12. (continued)

Soil	Major attributes[1]	Great soil group[2]	Main principal profile forms[3,4]	Predominant natural vegetation
Holding	A linear and lattice gilgai complex overlying cemented gravel and sandy clay			
	Mounds: firm to self-mulching, red-brown to grey-brown clay with alkaline reaction trend	No suitable group and red, brown and grey clay	Uf6.31, Ug5.38, Ug5.34, Ug5.3, Ug5.22, Uf6.33	Inland bloodwood, tall to mid-high, open woodland to woodland
	Depressions: self-mulching, grey-brown to dark, cracking clay with alkaline reaction trend	Grey and brown clay and black earth	Ug5.2, Ug5.24, Ug5.28, Ug5.3, Ug5.17	
Diamond	A self-mulching, red-brown to brown, cracking clay with alkaline reaction trend overlying brightly coloured clay interbedded with layers of weathered basalt	Red and brown clay	Ug5.38, Ug5.34, Ug5.39, Ug5.3	Queensland bluegrass, tall, tussock to open tussock grassland
Diamond, footslope variant	A coarse self-mulching, red-brown to grey-brown, cracking clay with acid to alkaline reaction trend overlying strongly and coarsely mottled, acid, gleyed clay below 400 mm depth	Grey, brown and red clay	Ug5.39, Ug5.38, Ug5.35, Ug5.34, Ug5.2	Queensland bluegrass-mitchell grasses, tall, tussock to open tussock grassland
Manar	A very fine self-mulching, red to brown, cracking clay with alkaline reaction trend overlying brightly coloured clay interbedded with layers of weathered basalt	Red and brown clay	Ug5.38, Ug5.34, Ug5.3	Gidgee and brigalow, tall to mid-high, open forest to woodland
Vicenza	A very fine self-mulching, grey to grey-brown, cracking clay with acid to alkaline reaction trend either overlying buried clay layers or overlying strongly and coarsely mottled, acid, gleyed clay	Grey clay	Ug5.24, Ug5.25, Ug5.2, Ug5.28, Ug5.29	Gidgee and brigalow, tall to mid-high, open forest to woodland

Table 12. (continued)

Soil	Major attributes[1]	Great soil group[2]	Main principal profile forms[3,4]	Predominant natural vegetation
Martyr	A normal, lattice and linear gilgai complex overlying cemented gravel and sandy clay			
	Mounds: hard setting to self-mulching, grey to brown clay with neutral to alkaline reaction trend	No suitable group and clay	Uf6.33, Ug5.2, Ug5.24, Ug5.28, Uf6.31	Gidgee and brigalow, tall to mid-high, open forest to woodland or boree, tall to mid-high, woodland to open forest or coolibah, tall open woodland to woodland
	Depressions: self-mulching, dark to grey, cracking clay with neutral to alkaline reaction trend	Black earth and grey clay	Ug5.16, Ug5.15, Ug5.2	
Kenmar	A normal, linear and lattice gilgai complex overlying buried layers			
	Mounds: self-mulching to firm, grey to grey-brown clay with acid to alkaline reaction trend	No suitable group and grey clay	Uf6.33, Ug5.25, Ug5.24,	Gidgee and brigalow, tall to mid-high, open forest to woodland
	Depressions: very fine self-mulching, dark to grey-brown, cracking clay with acid to alkaline trend	Grey clay and black earth	Ug5.24, Ug5.15, Ug5.25	

Table 12. (continued)

Soil	Major attributes[1]	Great soil group[2]	Main principal profile forms[3,4]	Predominant natural vegetation
Kenmar, melonhole phase	Similar to Kenmar, except for the following: - melonhole gilgai (vertical interval .30-1.0 m, horizontal interval 10-30 m); - may have abundant, fine to coarse, quartz and ironstained gravel on the surface of mounds; - a generally coarser self-mulching surface in depressions; - sporadic bleach may be present below the self-mulch in depressions; - the strongly and coarsely mottled, acid, gleyed clay may be encountered from 750 mm depth in depressions			
Midden	A lattice, normal and linear gilgai complex overlying buried layers			
	Mounds: self-mulching to hard setting, brown to red-brown clay with neutral to alkaline reaction trend	No suitable group and brown and grey clay	Uf6.31, Uf6.33, Ug5.35, Uf6.4, Ug5.2	Gidgee and brigalow, tall to mid-high, open forest to woodland
	Depressions: very fine self-mulching, dark to grey-brown, cracking clay with acid to alkaline reaction trend	Grey clay and black earth	Ug5.24, Ug5.16, Ug5.15, Ug5.25	

Table 12. (continued)

Soil	Major attributes[1]	Great soil group[2]	Main principal profile forms[3,4]	Predominant natural vegetation
Midden, melonhole phase	Similar to Midden, except for the following: - melonhole gilgai (vertical interval .35-1.30 m, horizontal interval 10-20 m); - very few to many, fine to coarse, quartz and ironstained gravel on the surface of mounds and depressions; - a generally coarser self-mulching surface in depressions; - sporadic bleach may be present below the self-mulch in depressions; - the strongly and coarsely mottled, acid, gleyed clay may be encountered from 600 m depth in depressions			
Well	A very fine self-mulching, brown to red-brown, cracking clay with acid reaction trend overlying strongly and coarsely mottled, acid, gleyed clay	Brown and red clay	Ug5.38, Ug5.39, Ug5.34, Ug5.35, Ug5.3	Gidgee and brigalow, tall to mid-high, open forest to woodland
Well, footslope variant	A coarse self-mulching, grey, brown and red, cracking clay with acid reaction trend overlying strongly and coarsely mottled, acid, gleyed clay	Grey, brown and red clay	Ug5.24, Ug5.2, Ug5.35, Ug5.38, Ug5.3	Boree, tall to mid-high, woodland to open forest or gidgee and brigalow, tall to mid-high, open forest to woodland
- Low-lying, level plains				
Well, sandy surface variant	A flaking, red-brown to brown, mainly non-cracking clay with sand veneer and acid reaction trend overlying strongly and coarsely mottled, acid, gleyed clay by 900 mm depth	No suitable group and red and brown clay	Uf6.31, Ug5.39, Ug5.35	Yapunyah, very tall to tall, open woodland to woodland or gidgee, tall to mid-high, woodland
Maraconda	A coarse self-mulching, grey, cracking clay with acid reaction trend overlying strongly and coarsely mottled, acid, gleyed clay	Grey clay	Ug5.25, Ug5.24, Ug5.29	Queensland bluegrass-mitchell grasses, tall, tussock to open tussock grassland

Table 12. (continued)

Soil	Major attributes[1]	Great soil group[2]	Main principal profile forms[3,4]	Predominant natural vegetation
Nungaroo	A melonhole and normal gilgai complex overlying strongly and coarsely mottled, acid, gleyed clay			
	Mounds: hard setting to self-mulching, red-brown to grey-brown clay with acid to alkaline reaction trend	No suitable group and brown clay	Uf6.31, Ug5.3, Uf6.33, Ug5.25	Gidgee and brigalow, tall to mid-high, open forest to woodland
	Depressions: self-mulching, grey-brown, cracking clay with acid reaction trend	Grey and brown clay	Ug5.24, Ug5.25, Ug5.3	
Soils overlying Quaternary alluvium:				
- Alluvial plains				
Moramana	A self-mulching, grey to red-brown, cracking clay with alkaline to neutral reaction trend overlying unconsolidated sediments or buried rock	Grey, brown and red clay	Ug5.25, Ug5.34, Ug5.38, Ug5.24, Ug5.3, Ug5.2	Coolibah, tall, open woodland to woodland
Moramana, gilgai phase	A linear to lattice gilgai complex overlying cemented gravel and sandy clay			
	Mounds: very fine self-mulching, red-brown to brown, cracking clay with alkaline reaction trend	Brown and red clay	Ug5.3, Ug5.34, Ug5.38	Coolibah or mountain coolibah, tall, open woodland to woodland
	Depressions: self-mulching, grey to red-brown, and occasionally dark, cracking clay with alkaline reaction trend	Grey and brown clay and black earth	Ug5.2, Ug5.25, Ug5.3, Ug5.1	

Table 12. (continued)

Soil	Major attributes[1]	Great soil group[2]	Main principal profile forms[3,4]	Predominant natural vegetation
Solferino	A very fine self-mulching, red-brown to grey-brown and occasionally grey, cracking clay with alkaline to reaction trend overlying unconsolidated sediments or buried rock	Red, brown and grey clay	Ug5.34, Ug5.39, Ug5.38, Ug5.24, Ug5.3	Gidgee and brigalow,tall to mid-high, open forest to woodland
Jeffray	A self-mulching, grey to dark, cracking clay with acid to neutral reaction trend overlying strongly and coarsely mottled, acid, gleyed clay	Grey clay and black earth	Ug5.2, Ug5.1, Ug5.28, Ug5.25, Ug5.24	Coolibah, tall, open woodland to woodland
Cattle	A very fine self-mulching, grey to dark, cracking clay with acid reaction trend overlying buried sand layers and/or strongly and coarsely mottled, acid, gleyed clay	Grey clay and black earth	Ug5.2, Ug5.15, Ug5.24, Ug5.25, Ug5.29	Gidgee and brigalow, tall to mid-high, open forest to woodland
Fletcher	A firm to hard setting, red to grey-brown, non-cracking clay with neutral to alkaline reaction trend overlying unconsolidated sediments	No suitable group	Uf6.31, Uf6.33	Poplar box or coolibah, tall, open woodland to woodland
- Valley flats				
Miscell-aneous soils	A range of duplex soils with hard setting, loamy sand to clay loam surface soils and bleached subsurfaces over alkaline to neutral clay subsoils overlying unconsolidated sediments	Solodic-solodized solonetz	Dd1.43, Dy3.43, Dy3.32	

1 All clay surfaces have a strongly developed, fine self-mulch unless described otherwise.

2 Great Soil Group after Stace *et al.* (1968), A Handbook of Australian Soils.

3 Principal Profile Form after Northcote, K.H. (1979), A Factual Key for the Recognition of Australian Soils.

4 The main principal profile forms are listed according to frequency of occurrence.

On the Mt. Lebanon property this gently undulating landscape surrounds an extensively dissected area of rolling low hills and plateau remnants. The rolling low hills are formed on a variety of calcareous sedimentary rocks containing abundant fossil shells. The word **Clarkei** has been taken from the name for the most common fossil shell and used for the gravelly and generally shallow loam, sand and duplex soil that has developed. **Clarkei** is characteristically associated with mountain coolibah open woodland to woodland. The plateau remnants contain the stony and shallow **Clarkei, clay surface variant** under a brigalow open forest, where it has not been cleared.

8.1.3 Soils overlying Tertiary volcanic and pyroclastic rocks

The shallow, very rocky and stony **Commissioner** soil occurs on domes, plugs, dykes and other intrusions of acid to intermediate volcanic rocks. These intrusions form very steep hills to gently undulating rises between the Gemini Mountains and Red Riding Hood Mountain, at the northern end of the Peak Range. Included in this landscape are very small outcrops of an unnamed sequence of Devonian/Carboniferous volcanic rocks. The consistently dark colour is a unique feature of this soil compared with other shallow soils in the study area. **Commissioner** is surrounded by a Tertiary basalt landscape which is apparently derived from the same primary magma as the acid to intermediate volcanic rocks (Veevers *et al.* 1964).

The other soils in this landscape unit overlie a range of materials that have been collectively mapped as Tertiary basalt by (Veevers *et al.* 1964) and cover most of the area south of Logan Creek.

The shallow, stony **Cheeseboro** soil occurs on a variety of landforms throughout the basalt. Either mountain coolibah or gum topped bloodwood open woodlands and woodlands are a common indicator of this shallow soil although deeper soils are often associated with this vegetation as well. **Cheeseboro** can also occur under Queensland bluegrass downs. The very shallow, hard setting profiles are restricted to prominent rises and low hills. Included with **Cheeseboro** are areas of predominantly rock outcrop such as Black Mountain, Mt. Falkner and Bluchers Knob which probably represent the final filling of volcanic vents that fed the basaltic lava to the surface (Veevers *et al.* 1964).

Most of the basalt landscape consists of the deeper **Russell, Falkner, Russell, gilgaied phase** and **Russell, stony phase** soils. Apart from the latter, these are also the major soils being cultivated in the area. **Falkner** is a greyer and darker soil, has a coarser self-mulch and slightly heavier surface texture than the others. It occurs under Queensland bluegrass downs in the south-west corner of the study area. The other soils have generally brighter hues and are naturally vegetated by either Queensland bluegrass downs or gum topped and mountain coolibah open woodlands and woodlands. The linear and lattice gilgai of **Russell, gilgai phase** are removed with constant cultivation and it is likely that large areas of this soil could have been identified prior to cultivation. The surface soil on the gilgai mounds commonly has a finer self-mulch and more calcareous nodules than surface soil in the adjacent depressions or in **Russell** soil. **Russell, stony phase** occurs sporadically throughout the basalt landscape, usually as small unmappable areas near **Cheeseboro**.

Both the presence of eucalypts and the abundance of surface gravel when considered individually, were found to be unreliable indicators of depth to basalt in the downs and eucalypt open woodlands to woodlands. However, the probability of successfully identifying shallow soils is increased if both eucalypts and surface gravel are present in abundance, and if the slope position is either crest or upper slope (Shields 1986).

Niagara and **Rankin** soils occur under gidgee and brigalow scrub and have finer self-mulching surfaces than the soils under Queensland bluegrass downs and eucalypt open woodlands to woodlands.

Niagara also tends to be deeper and have fewer surface cracks and lighter surface texture than **Falkner** and the various **Russell** soils. According to Galloway (1967a and 1967c), the extrusion of basalt occurred during at least two periods, separated by intervals of erosion and deposition. The deeper **Niagara** soil may be derived from basalt of an earlier extrusive phase that has weathered for a longer period than has the basalt below **Russell** and **Falkner**. **Russell, stony phase** and **Cheeseboro** often occur where **Niagara** interfingers with **Russell.** There are only two known occurrences of the darker and heavier **Rankin** soil north of Mt. Rankin where it appears to be formed on shallow basalt flows covering clay and minor sand deposits that have accumulated in former lake beds.

Dickson soil occurs under gidgee and brigalow scrub as well as under Reid River box open woodlands to woodlands. This firm to hard setting, clay soil is non-cracking and has a characteristic neutral to slightly acid surface pH whereas all other soils overlying basalt have are alkaline at the surface. It generally has lighter textures and lower pH through the profile than the other basalt soils. This may be due to more intense weathering and **Dickson** may be derived from a deeply weathered basalt of an early extrusive phase. Profiles under the Reid River box open woodlands to woodlands are generally deeper and have weaker structure than the scrub profiles.

The **Kenlogan** soil overlies red tuff, a volcanic ash that has settled and consolidated. Basalt gravels are often found on the soil surface and immediately above the tuff indicating that **Kenlogan** may have formed from shallow basalt flows and associated alluvium that have extensively covered the tuff. However, coverage is not entire and occasional outcrops of tuff also occur within areas of **Kenlogan** soil. The soil is morphologically similar to **Niagara** though it may have fewer surface cracks and lower profile pH. **Kenlogan**, **Dickson** and **Niagara** soils are commonly associated with **Kenlogan**.

The **Dickson, shallow variant** is a gravelly, non-cracking clay occurring in small areas throughout the basalt landscape. It overlies weathered basalt and acid volcanic gravel around Wondabah and red tuff in the Hyland Downs area.

8.1.4 Soils overlying Cainozoic limestone

Deposits of Cainozoic limestone occur mainly within the basalt landscape and were probably formed in lakes, swamps and streams. **Windradene** is a shallow clay soil derived principally from limestone although the presence of other gravel indicates an influence of additional materials in its development as well. The gravelly, shallow **Yackadoo** soil occurs mainly between Greenmantle and Kiandra where a shallow layer of quartz gravel covers the limestone deposits. In contrast with **Windradene,** this soil has mainly quartz gravel on the surface and through the profile.

Where **Windradene** occupies the crests and upper slopes, the deeper **Aroa** soil, with its linear and lattice gilgai, is generally associated downslope. **Aroa** often grades into **Russell** soil and at the interface can occur on calcium carbonate enriched basalt.

8.1.5 Soils overlying Cainozoic ferricrete and weathered sediments

Lebanon and **Villafranca** soils occupy level to gently undulating plains in the area bounded by Ok, Rugby, Mt. Lebanon and Charlton Park holdings. The plains are formed on ferruginised and weathered deposits fringing the higher-lying Permian sedimentary rocks. **Lebanon** is a mottled duplex soil with poplar box open woodlands to woodlands. The presence of ferruginised gravel through the profile and a ferruginised substrate distinguish this soil from **Heyford. Villafranca** is a red massive gradational soil with Queensland grey ironbark open woodlands to woodlands.

Lebanon, red variant is a red duplex soil that commonly forms a transition zone between **Lebanon** and **Villafranca** as well as being associated elsewhere with **Lebanon** in small, unmappable areas. Its predominant natural vegetation is mountain coolibah open woodlands to woodlands.

Ok (pronounced Okay) and **Ok, gravel phase** frequently occur at the margins of these plains where they merge downslope into extensive clay plains. These hard setting, red clay and gradational soils have gidgee and brigalow scrub as their natural vegetation and overlie a mixture of substrates including ferricrete and weathered sediments. **Ok, gravel phase** is distinguished from **Ok** on the basis of having at least 10% gravel through the profile and more than 20% in some layer, whereas **Ok** has 10% or less gravel throughout except in the surface soil or at the bottom of the subsoil.

8.1.6 Soils overlying Cainozoic gravelly sediments

Gravelly, unconsolidated sediments have accumulated at the margins of the Pre-Devonian Anakie Metamorphics between Winvic and Niagara and at the margins of mainly Devonian-Carboniferous rocks in the Mt. McLaren-Mt. Rankin area further north. The shallow **Winvic** soil occurs on gently undulating rises to level plains between Winvic and Niagara and has characteristic Dawson gum woodlands to open woodlands. The relatively deeper **Apron** soil occurs on similar landforms in the northern area under brigalow open forests to open woodlands. **Apron** occurs downslope from **Violet.** Both soils are distinguished from the similar **Ok** and **Ok, gravel phase** by the type of substrate and the nature of gravel in the profile. **Winvic** and **Apron** contain predominantly quartz and other gravel whereas **Ok** and **Ok, gravel phase** have rounded, ferruginised gravel.

8.1.7 Soils overlying Cainozoic clay sediments

North of the basalt and to the west of the Cainozoic ferricrete and other weathered sediments lies an extensive area of unconsolidated clay sediments. The clay sediments and basalt interfinger along their boundary and small, unmappable areas of sediments may occur within the basalt landscape. The landform immediately adjacent to the basalt and ferricrete landscapes consists of level to gently undulating plains that are elevated 10 to 40 m above other level plains in the north-west corner of the study area. The decrease in elevation is commonly sharp along the transition zone producing gently undulating to undulating rises. According to Galloway (1967c), the elevated plains and rises are probably formed on extensive alluvial fan deposits which accumulated during a number of stages (see section 5.1). The fan deposits appear to have overtopped an older, possibly Tertiary, clay deposition which forms the substrate for the low-lying plains in the north-west.

Regardless of the landform, the soils overlying the Cainozoic clay sediments can be placed into two broad groups based upon their predominant natural vegetation. Soils with downs and eucalypt open woodlands to woodlands have a coarser self-mulch and tend to have more surface cracks than the soils with mainly gidgee, brigalow and boree scrub. Apart from these features, the soils under both types of vegetation can be very similar. Table 13 lists the different soils that have been identified under each vegetation as well as those soils that have different vegetation but similar soil features.

The topographic relationship between soils with downs and eucalypt vegetation vary is shown in Figure 3. **Eleanor** and **Diamond** overlie material of basaltic origin which, in turn, overlies strongly and coarsely mottled, acid, gleyed clay. Galloway (1967a and 1967c) referred to the acid, gleyed clay as Tertiary clays. It is not known whether the Tertiary clays are related to the soil material above or represent a distinct geological layer (see section 5.1). **Eleanor** is a greyer soil with pH at depth between 6 and 8.5 whereas the brighter coloured **Diamond** soil has an alkaline reaction trend. **Eleanor, mottled phase** and **Diamond, footslope variant** directly overlie Tertiary clays but

may have developed from material of basaltic origin. **Holding** is the only soil with prominent gilgai and overlies material of mixed origin including basalt and metamorphic rocks. The **Diamond, footslope variant** has a coarse self-mulch similar to **Maraconda** soil with which it merges. **Maraconda** directly overlies Tertiary clays.

Table 13. Approximate soil, vegetation and substrate material relationships on the Cainozoic clay sediments

Nature of substrate	Similar soils under -	
	Scrub	Downs and associated eucalypts
Mainly basalt	Manar	Diamond
Either basalt or Tertiary clays	Vicenza	Eleanor and Eleanor, mottled phase
Mixed sediments including basalt	Martyr	Holding
Mixed sediments but excluding basalt	Kenmar	no equivalent
Mixed sediments but excluding basalt	Midden	no equivalent
Mixed sediments but excluding basalt	Kenmar, melonhole phase	no equivalent
Mixed sediments but excluding basalt	Midden, melonhole phase	no equivalent
Tertiary clays	Well	Diamond
Tertiary clays	Well, footslope variant	Diamond, footslope variant
Tertiary clays	Well, sandy surface variant	no equivalent
Tertiary clays	Nungaroo	no equivalent

The topographic relationship of the mainly scrub soils is shown in Figure 4. **Manar** is the only soil that consistently overlies material of basaltic origin and is only located adjacent to the basalt. **Vicenza** appears to directly overlie either material of basaltic origin or Tertiary clays. **Martyr** has prominent gilgai and overlies material of mixed origin including basalt. The **Well** soil directly overlies Tertiary clays but the bright colours and alkaline pH in the upper profile indicate it may be developed from material of basaltic origin. If this is the case, it forms the scrub counterpart to those areas of **Diamond** soil not adjacent to basalt. However, **Well** has an acid reaction trend suggesting that the soil and/or parent material has experienced more severe weathering than **Diamond.** The **Well, footslope variant** is a scrub counterpart to **Diamond, footslope variant** and has a similar coarse self-mulch. The **Well, sandy surface variant** directly overlies Tertiary clays at relatively shallow depth and occurs in small areas at the edge of the alluvial fans. In these areas, natural erosion appears to be stripping the fan deposits off the Tertiary clays. Neither this soil nor **Nungaroo,** a soil with prominent gilgai overlying Tertiary clays, have a downs counterpart.

Gilgai microrelief is a prominent feature of **Kenmar** and **Midden** soils. These soils tend to fringe the Permian sedimentary rocks and ferruginised sediments to the east rather than the basalt landscape to the south. They either overlie a mixture of clay, weathered sandstone and sand or overlie Tertiary clays. There is no direct evidence of sediments derived from basalt at depth. **Kenmar** has been distinguished from **Midden** on the basis of greyer colours for the mound profiles as well as having fewer profiles overlying the mixed substrate. The depression profiles are almost identical. **Kenmar, melonhole phase** and **Midden, melonhole phase** occupy topographic positions below **Kenmar** and **Midden**. Both melonhole phases are highly variable with respect to vertical interval, horizontal interval and dominant component of the microrelief as well as abundance of surface gravel.

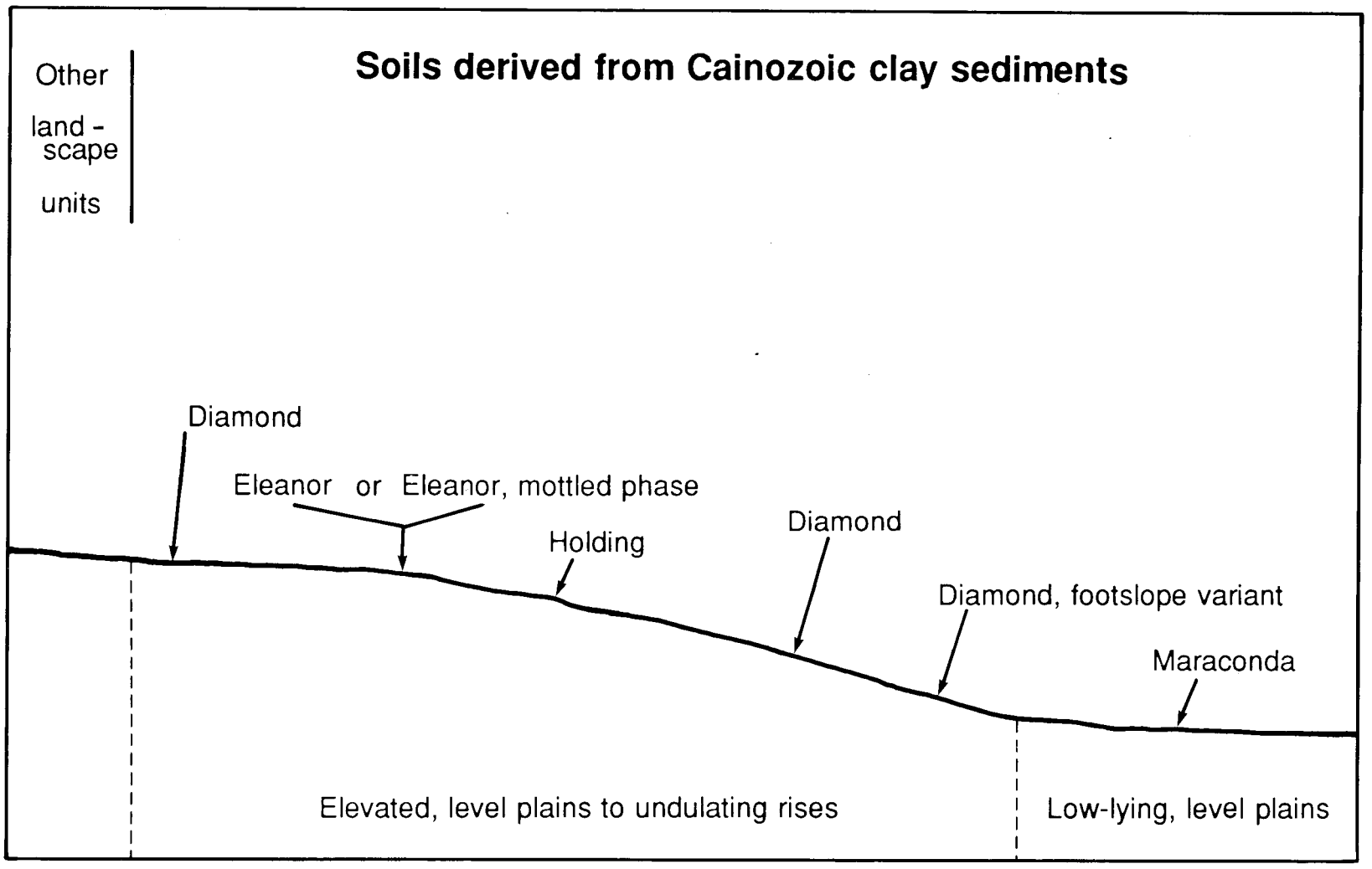


Figure 3. An idealised topographic relationship between soils overlying Cainozoic clay sediments with mainly scrub vegetation

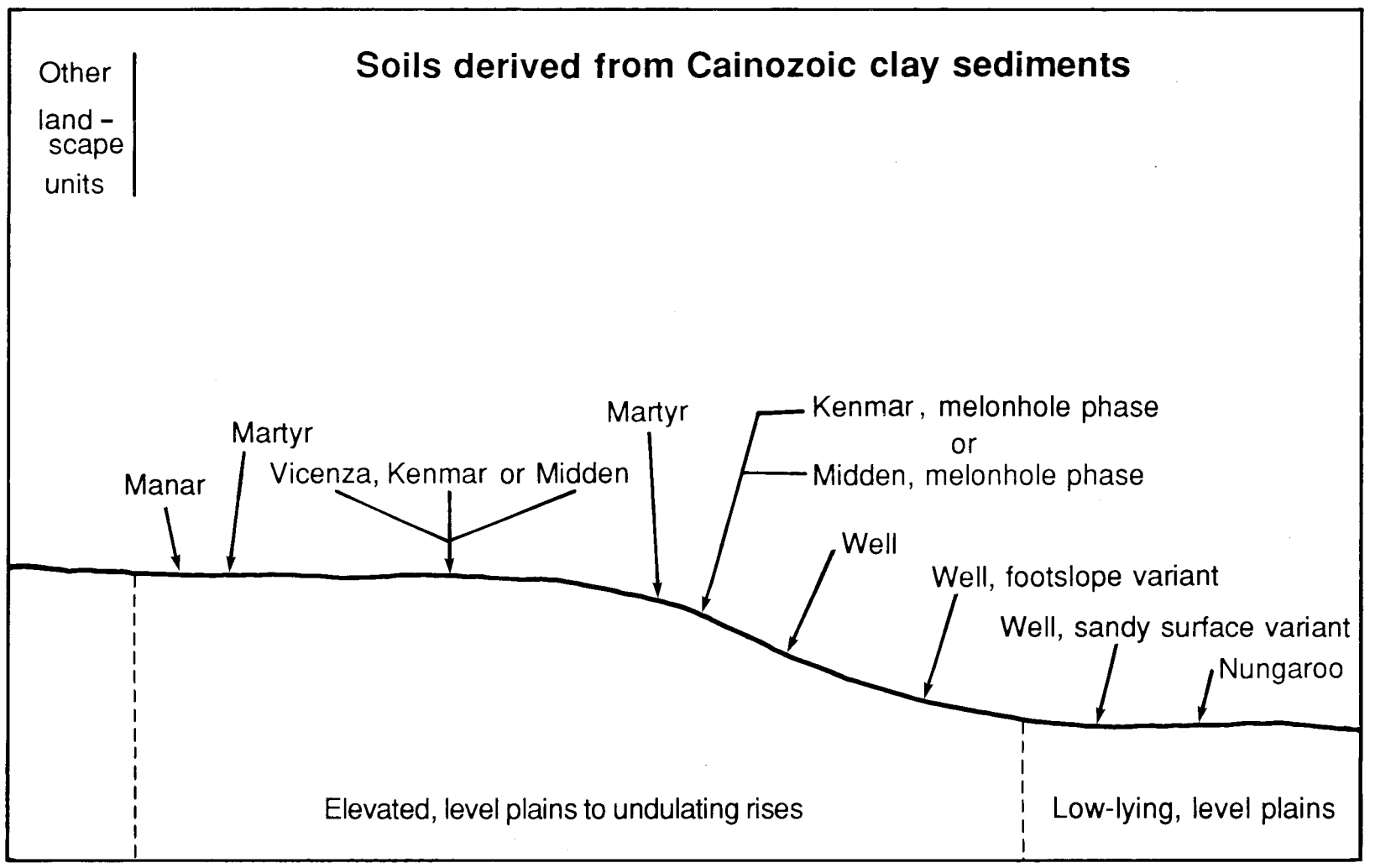


Figure 4. An idealised topographic relationship between soils overlying Cainozoic clay sediments with downs and associated eucalypt vegetation

Several of the soils on the elevated, level plains to undulating rises have a highly variable reaction trend. Profiles with strongly acid and strongly alkaline pH may occur within metres of each other. This variation may reflect the wide range of parent material involved.

8.1.8 Soils overlying Quaternary alluvium

Moramana, Solferino and **Moramana, gilgai phase** are situated on alluvial plains derived from basaltic material. **Moramana** has coolibah open woodlands to woodlands while **Solferino** occurs under gidgee and brigalow scrub. **Moramana** has a generally greyer colour and coarser self-mulch than **Solferino**. Both soils may overlie rock within the basalt areas but beyond the basalt overlie a mixture of unconsolidated sediments. **Moramana, gilgai phase** has linear and lattice gilgai on slightly elevated alluvial plains that may be relict from flooding. It occurs in the southern half of the study area under coolibah and some mountain coolibah open woodlands to woodlands. The soil overlies material of mixed origin, which although mainly basaltic, appears very similar to the substrate under **Holding** and **Martyr** soils. This suggests the slightly elevated alluvial plains were deposited at the same time as the alluvial fans further north.

The **Jeffray** and **Cattle** soils occur on alluvial plains in the north-west derived from Cainozoic sediments of mixed origin. **Jeffray** has coolibah open woodlands to woodlands and a generally coarser self-mulch than **Cattle** which occurs under gidgee and brigalow scrub. Both soils overlie Tertiary clays or buried sand layers. There is usually no visible difference in elevation between **Jeffray** and the adjacent **Maraconda** soil that is developed on Cainozoic clay sediments.

Fletcher is a red to grey-brown, non-cracking clay with poplar box or coolibah open woodlands to woodlands. It may have abundant surface gravel as well as many gravel at depth. Although many of the gravel are basalt, the soil occurs on alluvial plains in close proximity to non-basalt areas.

A range of duplex soils occupies the valley flats and narrow alluvial plains within the Permian sedimentary rocks. These **Miscellaneous soils** mainly overlie recent unconsolidated sediments but may also overlie the hard Permian rocks along the margins of the valley flats.

8.2 Soil correlation

The soils of the Kilcummin area have been described in previous land systems and soil surveys. The approximate correlations of soil profile classes identified during the present survey with the soils identified in three previous surveys are given in Table 14. The soil units established by Isbell and Hubble (1967) and Isbell *et al.* (1967) are soil-landscape associations and can not been used for correlation.

The surveys were conducted at different scales, thus the detail of the soil descriptions will vary and the correlations are only approximate. Only the soils from the present survey that have an approximate correlation elsewhere are listed in Table 14 and the correlated soils do not necessarily cover the entire range of the Kilcummin soil profile classes.

McDonald and Baker (1986) have described the soils on the left bank of the Emerald Irrigation Area. Their soil survey was very detailed and several of their soils (BUg-2,3,10,12,14,15) fit within **Russell** and **Russell, stony phase** identified at Kilcummin. In addition, the **Cheeseboro** soil at Kilcummin covers both BUg-1 and BUg-9 soils and **Russell, gilgai phase** encompasses the BUgg-1,2,4,5 soils from Emerald.

Table 14. Approximate correlation of soil profile classes with previously established soils

Soil profile class[a] (Kilcummin)	Soil family[b] (Gunn 1967a,1967b)	Soil group[c] (Isbell 1962)
Soils overlying Devonian-Carboniferous acid volcanic and minor sedimentary rocks		
Violet	Shotover, Rugby	
Soils overlying Permian sedimentary rocks		
Cherwell	Shotover	
Heyford	Luxor, Springwood	
Soils overlying Tertiary volcanic and pyroclastic rocks		no equivalent
Commissioner	Rugby, Shotover	
Cheeseboro	Rugby, Bruce	
Russell	Arcturus, May Downs, Glenora	
Russell, gilgai phase		
Russell, stony phase		
Falkner	Arcturus, May Downs	
Niagara	Glenora, May Downs	Sedentary clay soils
Rankin	May Downs	Sedentary clay soils
Kenlogan	Glenora	no equivalent
Soils overlying Cainozoic limestone		
Windradene	Gindie	
Yackadoo	Rugby	no equivalent
Aroa	May Downs?, Glenora?	
Soils overlying Cainozoic ferricrete and weathered sediments		
Lebanon	Luxor, Broadmeadow	
Villafranca	Dunrobin	
Ok	Cheshire	
Soils overlying Cainozoic gravelly sediments		
Apron	Cheshire	
Soils overlying Cainozoic clay sediments		no equivalent
Eleanor	Natal	
Eleanor, mottled phase		
Holding		
Diamond		
Diamond, footslope variant	Logan	
Manar	Natal	
Vicenza	Natal, Logan	Miscellaneous deep clay soils
Martyr	Natal	
Kenmar	Rolleston, Natal	
Kenmar, melonhole phase	Pegunny	Deep gilgaied clay soils
Midden	Rolleston, Natal	Miscellaneous deep clay soils
Midden, melonhole phase	Pegunny	Deep gilgaied clay soils
Well	Logan	Miscellaneous deep clay soils
Well, footslope variant	Logan	Miscellaneous deep clay soils
Maraconda	Logan	no equivalent
Nungaroo	Pegunny	Deep gilgaied clay soils

Table 14. (continued)

Soil profile class[a] (Kilcummin)	Soil family[b] (Gunn 1967a,1967b)	Soil group[c] (Isbell 1962)
Soils overlying Quaternary alluvium		
Moramana	Vermont	no equivalent
Solferino	Vermont	Alluvial clay soils?
Jeffray	Vermont?	no equivalent
Cattle	Vermont?	Alluvial clay soils?
Miscellaneous soils	Retro, Wyseby, Luxor?	no equivalent

[a] From the Kilcummin land resource survey (scale 1:100 000)
[b] From the Nogoa-Belyando and Isaac-Comet land systems survey (approximate scale of soils map 1:1 000 000)
[c] From the survey (approximate scale 1:1 500 000) of the soils and vegetation of the brigalow lands of eastern Australia

8.3 Mapping units

The soils are mapped as compound mapping units containing a dominant soil profile class with one or more associated soils. The mapping units are named after the dominant soil and their distribution is shown on the enclosed soils map.

An area that consists of a variety of soils with too few descriptions of each to adequately describe soil profile classes is referred to as **Miscellaneous soils**. The term was used here to describe the relatively narrow valley flats amongst the Permian sedimentary rocks that contain a range of duplex soils.

The total area of each mapping unit is given in Table 15. The area of a mapping unit only approximates the area of its dominant soil profile class since it also includes the area of associated soils. Moreover, the proportion of dominant soil may vary between UMAs for each mapping unit. The estimated proportion of every UMA that each soil occupies is given in the UMA data file.

Table 15. Mapping unit areas

Mapping unit	Area (ha)
Soils overlying Devonian-Carboniferous acid volcanic and minor sedimentary rocks:	
Violet	10 020
Soils overlying Permian sedimentary rocks	
Cherwell	12 950
Clarkei	3 110
Clarkei, clay surface variant	480
Heyford	14 520
Soils overlying Tertiary volcanic and pyroclastic rocks	
Commissioner	2 650
Cheeseboro	10 590
Russell	54 830
Russell, gilgai phase	710
Russell, stony phase	420
Falkner	7 870
Niagara	11 660
Rankin	370
Dickson	2 700
Dickson, shallow variant	580
Kenlogan	560
Soils overlying Cainozoic limestone	
Windradene	10 060
Yackadoo	1 510
Aroa	7 250
Soils overlying Cainozoic ferricrete and weathered sediments	
Lebanon	18 170
Lebanon, red variant	30
Villafranca	2 350
Ok	1 240
Ok, gravel phase	600
Soils overlying Cainozoic gravelly sediments	
Winvic	1 250
Apron	3 530

Table 15. (continued)

Mapping unit	Area (ha)
Soils overlying Cainozoic clay sediments	
- Elevated, level plains to undulating rises	
Eleanor	5 930
Eleanor, mottled phase	840
Holding	4 590
Diamond	2 880
Diamond, footslope variant	1 300
Manar	3 200
Vicenza	17 350
Martyr	1 840
Kenmar	7 720
Kenmar, melonhole phase	5 810
Midden	5 560
Midden, melonhole phase	2 560
Well	1 140
Well, footslope variant	3 480
- Low-lying, level plains	
Well, sandy surface variant	310
Maraconda	4 600
Nungaroo	1 640
Soils overlying Quaternary alluvium	
Moramana	17 000
Moramana, gilgai phase	2 160
Solferino	8 310
Jeffray	2 390
Cattle	1 200
Fletcher	2 280
Miscellaneous soils	1 120

8.4 Soil analytical data

Detailed morphological and laboratory data for the 55 soil profiles are given in Appendix III.

8.4.1 pH

The range in pH determined in the laboratory for Kilcummin soils is shown in Table 16. The soils have been grouped into landscape units for presentation and discussion of data. Field pH can be used confidently to predict laboratory determined pH in any soil and at any depth ($n=138$, $r^2=.89$, $P < .01$).

Table 16. The range in pH determined in the laboratory for Kilcummin soils

Soil group	Range in soil pH		Number of sites
	Surface[a]	Deep subsoil[b]	
Soils overlying Devonian-Carboniferous rocks	6.1	5.8	1
Soils overlying Permian sedimentary rocks	4.8-7.6	4.9-9.4	3
Soils overlying Tertiary volcanic and pyroclastic rocks			
- acid to intermediate volcanic rocks	6.8	6.3	1
- basalt and pyroclastic rocks	7.2-8.7	5.3-8.8[c]	9
Soils overlying Cainozoic limestone	8.2-8.8	8.0-9.1	4
Soils overlying Cainozoic ferricrete and weathered sediments	6.7-7.2	6.9-7.8	3
Soils overlying Cainozoic gravelly sediments	6.0-6.8	8.2-9.0	2
Soils overlying Cainozoic clay sediments			
- elevated, level plains to undulating rises	7.4-8.7	4.6-9.0	19
- low-lying level plains and footslopes	4.3-8.3	4.2-7.0	6
Soils overlying Quaternary alluvium	7.5-8.7	4.3-9.1	7

[a] Based on bulked, 0 to 100 mm, surface samples
[b] Taken at either the bottom of the soil profile or at 1 500 mm depth, whichever was shallower
[c] Only one profile (**Dickson**) overlying Tertiary basalt and pyroclastic rocks has acid pH at depth

Surface pH varies from 4.3 to 8.8. It is more uniform within individual soil groups although the soils overlying Permian sedimentary rocks and the soils of the low-lying level plains and footslopes have a quite variable pH at the surface.

The pH in the deep subsoil is generally similar to, or greater than, the surface value. Where the pH increases with depth, the rise is generally less than 2.5 units. However, pH decreases substantially (between 3.4 and 5.0 units) below the surface of several soils overlying Cainozoic clay sediments or Quaternary alluvium. Some soils within these groups also have both acid and alkaline reaction trends. The depression site of **Nungaroo** (S29) is exceptional with a surface pH of 4.3, increasing to 5.8 just below the surface, then decreasing to pH 4.2 at 1 500 mm depth.

Dickson is different to the other soils with basalt parent material as its field pH indicates a neutral to alkaline reaction trend but the laboratory determined pH was acid at depth in the representative profile. The lower pH suggests that weathering of **Dickson** parent material has been more severe than for the basalt under other soils.

Micronutrient disorders may occur in those soils with either very strongly acid to extremely acid pH or very strongly alkaline pH in the plant root zone. Aluminium toxicity can occur in acid soils especially where pH is less than 5.5. Manganese becomes more soluble in these soils as well and, if there is sufficient element present in the soil, may result in toxicity. Copper, zinc and molybdenum have also been shown to be deficient on acid, sandy soils. On the other hand, Williams and Colwell (1977) also report that copper, zinc and manganese may become unavailable to crops in highly calcareous soils with a high pH. The actual levels of extractable copper, zinc and manganese present in the surface soils are discussed in section 8.4.9.

8.4.2 Salinity

The Electrical conductivity (EC) and chloride (Cl) content of a 1:5 soil:water suspension were analysed to estimate salinity levels of Kilcummin soils. The Cl content can be used as an indicator of soil salinity if Cl is the dominant anion contributing to salinity under field conditions. Alternatively, EC values can be used to estimate the effect of all the soluble salts present in the soil. Many of the soils at Kilcummin have gypsum crystals present in the subsoil. These crystals dissolve when the soil is diluted with water to inflate $EC_{1:5}$ values above the levels that would occur under field conditions.

Shaw *et al.* (1987) have put forward criteria to determine whether the $EC_{1:5}$ values are inflated and a methodology for deriving the EC of a saturation extract (EC_{SE}) from the 1:5 figures as an attempt to overcome this problem. Their criteria indicate that 30 Kilcummin soil profiles would contain some gypsum whereas gypsum crystals were observed in 21 profiles during field sampling. There is also high variability ($n=180$, $r^2=.28$) associated with the regression equation proposed by Shaw *et al.* (1987) to predict EC_{SE} values in the presence of gypsum. This variability is expected because the equation accounts for the average of many soils having a wide range of salt composition (Shaw 1988). It is not necessarily an appropriate equation for predicting EC_{SE} in soils containing gypsum.

Three indexes of salinity, using $Cl_{1:5}$ and EC_{SE}, are presented in Table 17 for profiles representing the major soils at Kilcummin. Although a single index of profile salinity is convenient to use, it is possible to obtain the the same index for profiles that have markedly different EC and Cl gradients with depth. A single index provides a summary of profile salinity but should be considered in conjunction with actual values for soils with marked profile gradients. The weighted EC_{SE} profile values are calculated assuming that water uptake by plants is proportionally greater near the surface than in lower parts of the root zone. This method was developed for conditions of high frequency irrigation and is not necessarily appropriate for rainfed cropping at Kilcummin where the high evaporation rates will result in the soil immediately below the surface drying quickly.

Shaw *et al.* (1987) have established criteria to rate soil salinity on the basis of EC_{SE}. They have also calculated equivalent $EC_{1:5}$ and $Cl_{1:5}$ values for each rating. Alternatively, the earlier $CL_{1:5}$ rating system of Bruce and Rayment (1982) can be used. Regardless of the rating system used, the majority of soils at Kilcummin have very low to low salinity (≤ 1.9 dS/m EC_{SE} or $\leq 0.03\%$ $CL_{1:5}$ for the earlier system).

The soils overlying Cainozoic clay sediments vary from a low to extreme salinity rating on the basis of EC_{SE}. Salinity is consistently greater on the low-lying level plains and footslopes than on the elevated, level plains to undulating rises. The $Cl_{1:5}$ trend is similar, ranging from very low to high according to Bruce and Rayment (1982). Of the soils overlying Tertiary basalt and pyroclastic rocks, those with scrub vegetation (**Niagara**, **Rankin** and **Kenlogan** S25 profile) have a higher salinity than the remaining soils with downs and eucalypt vegetation.

Table 17. Salinity data calculated for profiles representing the major Kilcummin soils to a maximum 900 mm rooting depth

Soil	Average chloride$_{1:5}$ (%)	Average EC_{SE} dS/m	Weighted EC_{SE} dS/m
Soils overlying Devonian-Carboniferous rocks			
Violet	.002	.53	.53
Soils overlying Permian sedimentary rocks			
Cherwell	.001	.22	.22
Clarkei	.001	.64	.55
Heyford	.039	3.8	2.6
Soils overlying Tertiary volcanic and pyroclastic rocks			
- acid to intermediate volcanic rocks			
Commissioner	.001	.31	.31
- basalt and pyroclastic rocks			
Cheeseboro	.001	.40	.40
Russell	.001	.55-.61	.40-.61
Falkner	.001	.39	.36
Niagara	.023	2.6	2.0
Rankin	.053	3.9	2.5
Dickson	.001	.41	.40
Kenlogan	.002-.006	.26-.68	.29-.48
Soils overlying Cainozoic limestone			
Windradene	.002	1.2	1.3
Yackadoo	.001	1.1	1.1
Aroa	.001-.002	.62-.75	.59-.76
Soils overlying Cainozoic ferricrete and weathered sediments			
Lebanon	.001	.19	.19
Villafranca	.001	.23	.27
Ok	.001	.20	.21
Soils overlying Cainozoic gravelly sediments			
Winvic	.001	.91	.91
Apron	.004	1.2	.79
Soils overlying Cainozoic clay sediments			
- elevated, level plains to undulating rises			
Eleanor	.005-.006	1.1	.84-.95
Eleanor, mottled phase	.047	2.6	1.4
Holding	.001-.003	.98-.99	.84-.93
Diamond	.043	2.5	1.5
Manar	.016	5.1	2.5
Vicenza	.003-.106	2.4-5.0	1.4-2.4
Martyr	.019-.043	4.1-4.8	2.4-3.4
Kenmar	.029-.084	4.9-8.1	3.6-5.3
Kenmar, melonhole phase	.004-.014	1.6-1.7	1.2-1.3
Midden	.004-.030	1.3-3.2	1.1-1.8
Well	.025-.035	6.4-8.1	3.6-5.1

Table 17. (continued)

Soil	Average $chloride_{1:5}$ (%)	Average EC_{SE} dS/m	Weighted EC_{SE} dS/m
- low-lying level plains and footslopes			
Diamond, footslope variant	.050	2.0	1.1
Well, footslope variant	.085	16.9	15.7
Maraconda	.097-.153	12.3-13.1	9.7-11.1
Nungaroo	.019-.090	4.9-9.8	3.3-5.3
Soils overlying Quaternary alluvium			
Moramana	.020	1.3	.85
Moramana, gilgai phase	.002-.003	.58-.99	.46-.94
Solferino	.205	7.7	4.9
Jeffray	.045	3.0	2.3
Cattle	.027	4.7	2.1
Fletcher	.001	.78	.59

The soils overlying Quaternary alluvium have a variable salinity rating. Soils on alluvium derived from Tertiary basalt and pyroclastic rocks generally have very low to low salinity (with both rating systems). However, salt can accumulate towards the valley head where the alluvium becomes quite narrow. This is evident in the **Solferino** profile. **Moramana** and **Moramana, gilgai phase** were sampled further from the source material, where the alluvial plains become quite broad and had very low to low salinity. Soil salinity in the narrow alluvial plains draining Tertiary basalt and pyroclastic rocks was also checked at another site where an abundance of black tea tree indicated restricted site drainage. The salt content at this site was very low indicating that salt accumulation is sporadic on these narrow alluvial plains.

8.4.3 Particle size distribution

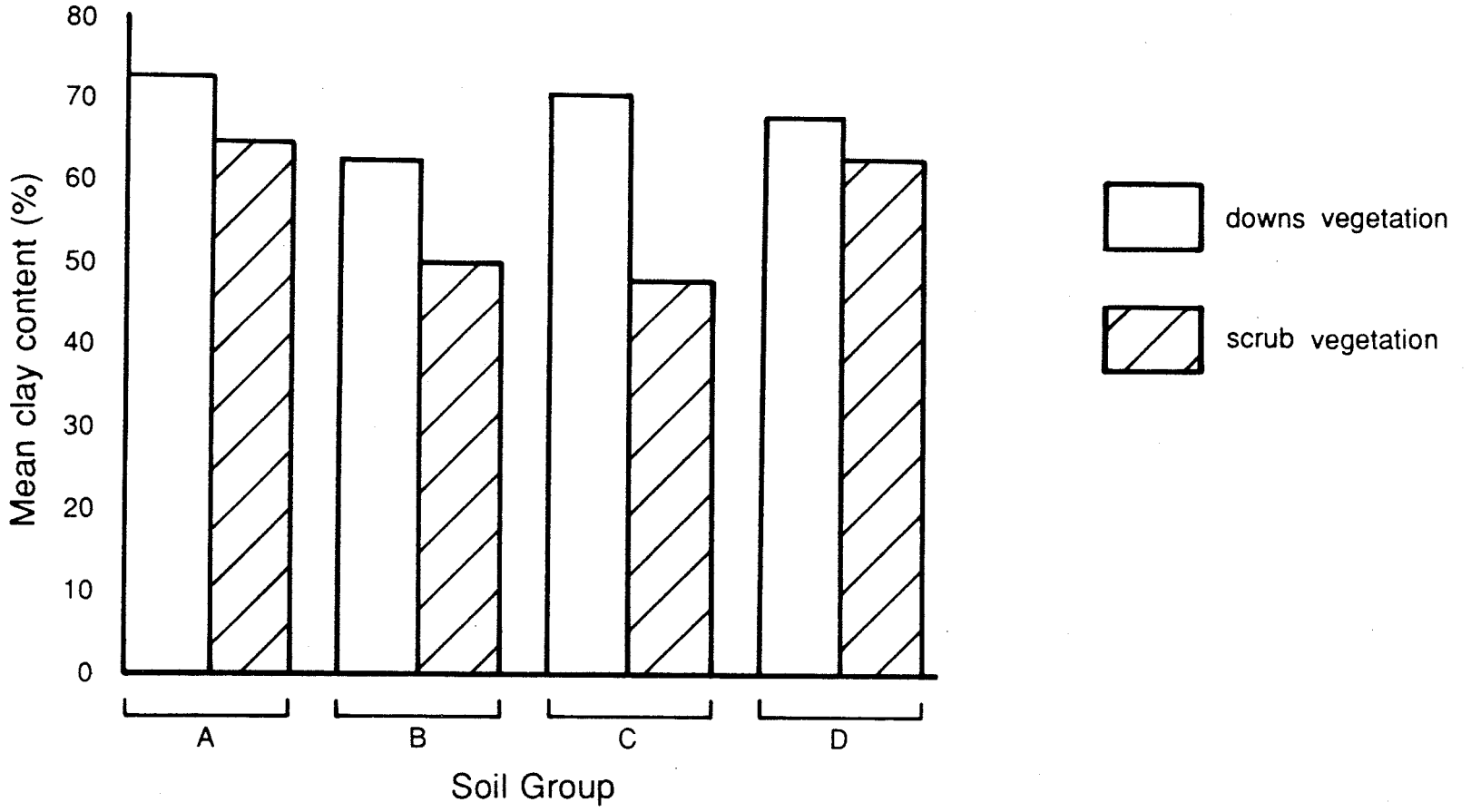
Appendix III contains the particle size distributions down the profiles of all major soils sampled. The distributions of clay, silt and sand generally agreed with the textures estimated in the field. Field texture gave a much higher estimate of clay content than the equivalent particle size analysis (PSA) in samples with a high proportion of fine sand plus silt (37 to 59%), and in samples which contained at least 20% small to medium pebbles. It is assumed that some pebbles were ground up during sample preparation causing distorted particle size values. The clay soils generally textured in the field as medium to heavy clays throughout but the PSA for several samples from these soils gave a lower clay content. The only soil to have its clay content underestimated in the field was **Dickson**, which textured as a light to light medium clay but had clay contents of 56 to 75%.

Clay content is highest (70-71%) on the cracking clays overlying either Quaternary alluvium or Tertiary basalt and pyroclastic rocks (Table 18). Compared with these soils, the cracking clays overlying Cainozoic clay sediments contain considerably less clay (55-62%), have a similar percentage of silt and a higher proportion of sand.

The cracking clays with downs and associated eucalypt vegetation have less clay in the plough zone than occurs in similar soils supporting scrub vegetation. This difference of 5-23% less clay is evident across all substrate materials (Figure 5). This observation contrasts with Macnish (1979) who found no significant differences in particle size distribution between soils supporting softwood scrub and those supporting eucalypt vegetation on the eastern Darling Downs.

Table 18. Clay content for cracking clays overlying various substrate material

Soil Group / Sample depth (mm)	% clay (Mean ± s.d.)	Number of samples
Cracking clays overlying Tertiary basalt and pyroclastic rocks		
0-100	69 ± 8	7
500-600	68 ± 10	7
Cracking clays overlying Cainozoic clay sediments		
- elevated, level plains to undulating rises		
0-100	55 ± 12	17
500-600	57 ± 12	19
- low-lying level plains and footslopes		
0-100	59 ± 14	6
500-600	62 ± 13	6
Cracking clays overlying Quaternary alluvium		
0-100	70 ± 6	6
500-600	71 ± 5	6



A Cracking clays overlying Tertiary basalt and pyroclastic rocks (downs n=4; scrub n=3)

B Cracking clays overlying Cainozoic clay sediments
- elevated, level plains to undulating rises (downs n=6; scrub n=13)

C Cracking clays overlying Cainozoic clay sediments
- low-lying, level plains and footslopes (downs n=3; scrub n=3)

D Cracking clays overlying Quaternary alluvium (downs n=4; scrub n=2)

Figure 5. Mean clay content in the surface soil (0-100 mm depth) of cracking clays with scrub and downs vegetation

8.4.4 Cation exchange capacity and clay activity ratio

The cation exchange capacity (CEC) of a soil indicates the potential storage of nutrient cations available for plant growth and is also related to water storage capacity (Shaw and Yule 1978).

The values obtained for CEC vary depending upon the pH of the solution used to extract cations. The laboratory values should more closely reflect actual field values if the pH of the extracting solution approximates the field pH. The CEC was determined at pH 8.5 for soils with an alkaline pH throughout the profile or at pH 7.0 for neutral to acid soils. The soils with an alkaline pH becoming acid at depth also had CEC measured at pH 8.5 throughout. These latter soils contained appreciable gypsum and soluble salts and the sum of exchangeable cations closely approximated the CEC with an extraction at pH 8.5 whereas, with extraction at pH 7.0, the sum of the exchangeable cations greatly exceeds the CEC values.

The range in CEC for the various soil groups at Kilcummin is given for two sampling depths in Table 19. For the soils with alkaline pH becoming acid with depth, the values in Table 19 are based upon extraction at pH 8.5 to facilitate comparison.

The CEC generally increases with increasing clay content. The only exception is **Dickson** soil, which has a high clay content but very low CEC. The CEC is highest for the cracking clays overlying Tertiary basalt and pyroclastic rocks.

Only **Villafranca**, **Violet** and the **Heyford** surface soil have low values (3-6 m.equiv./100 g) and these soils may have little ability to retain cations against leaching. The relatively high organic matter content of **Cherwell** is probably the reason for its relatively high CEC and would enable this soil to retain nutrients in the virgin state.

The clay activity ratio is the CEC of one gram of clay (m.equiv./g clay) and is often used as an indication of clay mineralogy where organic matter is not contributing significantly to the CEC. The range in clay activity ratios is given at two sampling depths for a number of soil groups in Table 19.

A ratio of 0.8 or higher generally indicates a dominance of smectites, the clays that shrink and swell with changing moisture status. Vermiculite also has a very high ratio but is not known as a major component of any Australian soil group (Norrish and Pickering 1983). The soils overlying overlying Tertiary basalt and pyroclastic rocks, Quaternary alluvium and **Aroa**, overlying Cainozoic limestone, are dominated by smectites. The only exceptions are **Dickson** and the **Kenlogan** profile sampled from a cleared gidgee scrub. In contrast, smectites dominate only one half of the soils overlying Cainozoic clay sediments. **Cherwell**, overlying Permian sedimentary rocks, and **Commissioner**, overlying Tertiary acid to intermediate volcanic rocks, have high ratios. These soils have a very low clay content and their relatively high CEC is probably due to their relatively high organic matter content rather than any dominance of smectites in the soil.

A clay activity ratio of 0.35 or less generally indicates a dominance of kaolin clays. The soils overlying Cainozoic ferricrete and weathered sediments and **Dickson** have a ratio in this range indicating they are composed of mainly kaolin clays. As well, **Dickson** is a red non-cracking clay with weak to moderate structure in the subsoil, a neutral to alkaline field pH in the subsoil but acid pH measured at depth in the laboratory. The acid profiles have similar properties to the Krasnozem Great Soil Group of Stace *et al.* (1968), the neutral profiles are similar to the Euchrozem Great Soil Group but the alkaline profiles do not fit well into any Great Soil Group. The dominance of kaolinclays for this soil rather than smectites that dominate the other soils overlying Tertiary basalt and pyroclastic rocks indicates more severe weathering of its parent material.

Table 19. The range in CEC and clay activity ratio at two sample depths for Kilcummin soil groups

Soil group / Sample depth (mm)	CEC (m.equiv./100 g)	Clay activity ratio (m.equiv./g clay)	Number of samples
Soils overlying Devonian-Carboniferous rocks			
0-100	6	0.75	1
Soils overlying Permian sedimentary rocks			
0-100	6-16	0.50-1.46	3
500-600	14	0.40	1
Soils overlying Tertiary volcanic and pyroclastic rocks			
- acid to intermediate volcanic rocks			
0-100	17	1.15	1
- basalt and pyroclastic rocks (excluding Dickson)			
0-100	40-107	0.53-1.53	8
500-600	47-106	0.79-1.44	6
- Dickson			
0-100	20	0.27	1
500-600	12	0.16	1
Soils overlying Cainozoic limestone			
0-100	21-88	0.71-1.24	4
500-600	67-91	1.13-1.17	2
Soils overlying Cainozoic ferricrete and weathered sediments			
0-100	6-16	0.24-0.61	3
500-600	5-17	0.14-0.29	3
Soils overlying Cainozoic gravelly sediments			
0-100	14	0.64-0.67	2
500-600	21	0.51	1
Soils overlying Cainozoic clay sediments			
- elevated, level plains to undulating rises			
0-100	26-76	0.68-1.13	19
500-600	25-77	0.58-1.14	19
- low-lying level plains and footslopes			
0-100	23-78	0.42-0.99	6
500-600	24-78	0.44-0.99	6
Soils overlying Quaternary alluvium			
0-100	60-71	0.77-1.16	5
500-600	56-82	0.71-1.12	6

8.4.5 Exchangeable cations

The value determined in the laboratory for exchangeable cations depends upon the pH of the solution used for extraction (see section 8.4.4). Exchangeable cations were determined at pH 8.5 for soils with an alkaline pH throughout the profile or at pH 7.0 for neutral to acid soils. For the soils with alkaline pH becoming acid with depth, the values are based upon extraction at pH 8.5 are used to facilitate comparison but the alternative CEC determination at pH 7.0 is given in Appendix III.

Exchangeable calcium levels are above 4 m.equiv./100 g in all soils except **Villafranca** and the shallow, coarse textured **Violet** and **Cherwell** soils. Calcium levels in **Violet** and **Cherwell** are less than 2 m.equiv./100 g, suggesting a deficiency for plant use may occur. Calcium is the dominant exchangeable cation in all surface soils apart from **Cherwell** and **Apron**, where sodium dominates the exchange complex. Calcium is also a major exchangeable cation in subsoils although exchangeable magnesium becomes dominant in the deep subsoil in almost one-third of the profiles sampled. Exchangeable magnesium levels vary between 2.8 and 39 m.equiv./100 g in cracking clays and between 0.3 and 12 m.equiv./100 g in other soils. **Violet**, **Cherwell**, **Clarkei**, **Villafranca**, **Winvic** as well as the surface soils of **Heyford**, **Ok** and **Apron** have less than 2 m.equiv./100 g of magnesium and are possibly deficient in this nutrient for plant growth.

Exchangeable potassium levels are medium to very high in most soils. The exceptions are **Commissioner** and the soils of the low-lying level plains and footslopes overlying Cainozoic clay sediments which have low to very low exchangeable potassium. In addition, the soils overlying Quaternary alluvium and those of the elevated, level plains to undulating rises overlying Cainozoic clay sediments have reasonable potassium levels in the surface but very low to low exchangeable potassium in the subsoil.

In Australian soils sodium is rarely deficient and often affects plant growth due to its presence in excess amounts. This aspect is discussed in section 8.4.7.

8.4.6 Total potassium, total phosphorus and total sulphur

Total potassium and total phosphorus levels reflect the parent material, clay mineralogy and age of soils. McDonald and Baker (1986) found that, on the Emerald alluvium, total potassium decreased with increasing soil age while Baker *et al.* (1985) reported a similar relationship for both total potassium and total phosphorus for alluvial landforms at Mackay.

Two distinct landscapes occur on the Cainozoic clay sediments at Kilcummin. The soils of the low-lying level plains and footslopes appear to have lower total phosphorus than the soils on elevated, level plains to undulating rises but the differences are not significant (Figure 6). Both soil groups have significantly lower total phosphorus levels (.014-.037%) than the soils overlying Quaternary alluvium (.038-.072%). There are no significant differences in total potassium between the three groups. The significantly higher total phosphorus in the soils overlying Quaternary alluvium may reflect the slightly higher proportion of these profiles dominated by smectites. On the other hand, the higher phosphorus levels may also indicate that either the Cainozoic unconsolidated sediments are deposited from a different source or their age of deposition and subsequent soil development is different from the Quaternary alluvium.

The levels in total sulphur can be used to indicate a presence and increase in gypsum in a soil profile. The total sulphur levels increases markedly in every profile in which gypsum was observed in the field and in one other profile (**Midden** depression) in which gypsum crystals were not recorded. Total sulphur levels often increased in the profile before gypsum was observed indicating that total sulphur can be used to estimate more accurately any fluctuations in gypsum content through a profile.

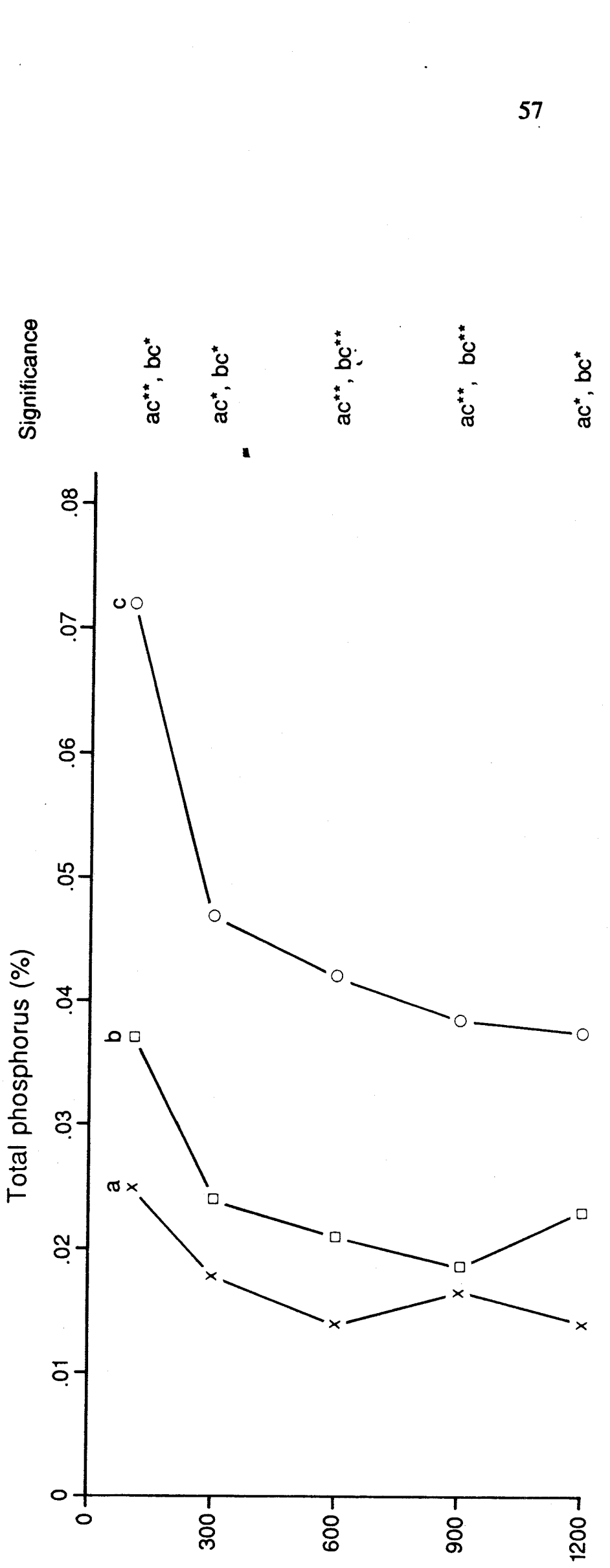


Figure 6. Mean total phosphorus profiles for three soil groups showing significant differences at 5% and 1% levels

8.4.7 Sodicity and other indexes of soil dispersion

Several indexes have been used in Australia to indicate soil dispersion. Dispersion results in loss of soil porosity and thus decreased permeability as well as increasing susceptibility to water erosion.

Northcote and Skene (1972) used exchangeable sodium percentage (exchangeable Na/CEC %) or ESP as a criterion for determining soil sodicity. They described a soil with an ESP of 6 to 14 as being sodic and with an ESP > 15 as being strongly sodic. Exchangeable magnesium, in association with sodium, has been shown to aid soil dispersion in some soils (Emerson and Bakker 1973). Clay subsoils with degraded structure but low ESP have been recorded in coastal Queensland by several authors (for example, Baker *et al.* 1985). The magnesium saturation (exchangeable Mg/CEC %) of these materials ranged from 64 to 83%. Stace et al. (1968, pp 185, 187) also include two soils from Glenelg (Victoria) with poorly structured subsoils, low ESP and magnesium saturation in excess of 40%. Emerson and Bakker (1973) also used Mg:Ca ratios to assess the physical performance of some Victorian soils. They suggested that Mg:Ca ratios greater than one associated with relatively low ESP can enhance clay dispersion.

Heyford is a duplex soil with a clay subsoil that is strongly sodic, has a Mg:Ca ratio greater than one and has a magnesium saturation of 40 to 63%. The clay subsoil is highly erodible. In contrast, **Lebanon** is a duplex soil with a non-sodic subsoil that has a Mg:Ca ratio of less than one and a magnesium saturation of less than 25%. This data does not agree with field evidence indicating that **Lebanon** has a highly erodible subsoil that is of very hard consistence when dry. The erodibility of **Lebanon** may be due to slaking and the impermeability of the clay subsoil may be due to its inherent mix of sand and clay rather than dispersion.

Most soils overlying Tertiary basalt and pyroclastic rocks are non-sodic and have favourable Mg:Ca ratios. However two soils with scrub vegetation, **Rankin** and **Niagara**, have sodic to strongly sodic subsoils with a Mg:Ca ratio greater than one from 600 mm depth. All the soils overlying Cainozoic clay sediments have sodic to strongly sodic subsoils from 600 mm depth. Magnesium saturation is less than 47% and the Mg:Ca ration is generally greater than one. The soils overlying Quaternary alluvium have non-sodic to strongly sodic subsoils with Mg:Ca ratios mainly less than one. The **Solferino** profile has an extremely sodic subsoil (ESP of at least 50% from 900 mm depth) indicating the influence of salt accumulation from the surrounding basalt landscape at this site. However, salt accumulation is not expected to be as significant in all areas of **Solferino** (see section 9.4.2).

Apron and **Ok** soils have strongly sodic subsoils from 1 200 mm and 900 mm respectively. Magnesium saturation is as high as 63% in the subsoils of both soils and the Mg:Ca ratio is greater than one below 600 mm. All other soils are non-sodic (ESP < 6).

8.4.8 Plant available water capacity

Plant available water capacity (PAWC) of the soils sampled for laboratory analysis was determined using the regression equations of Shaw and Yule (1978) based on the water content at -1500 kPa (Table 20). The figures were converted to volumetric water using a bulk density calculated from the maximum gravimetric water content, assuming a 5% air content at that point. The values were summed to a depth of 900 mm. This was taken as the effective rooting depth, unless an impermeable layer or maximum increase in chloride was encountered beforehand.

The largest PAWC values are in the range 130 to 145 mm. These values were estimated for the majority of clay soils with an effective rooting depth of 900 mm. Any clay soils with a shallower

rooting depth have a lower PAWC. The clay soils on the low-lying level plains and footslopes overlying Cainozoic clay sediments are very deep soils with a shallow rooting depth and quite low PAWC due to the accumulation of soluble salts close to the surface. This effect also occurs in **Jeffray** and **Solferino** soils. However, the **Solferino** profile was sampled from a saline site and is not expected to represent all areas of this soil. The PAWC for **Solferino** will probably be similar to **Moramana** in non-saline areas. Estimated PAWC for the non-cracking clay soils **Dickson** and **Ok** is not markedly different from cracking clays with similar rooting depth.

The sodic duplex soil **Heyford** has a very low PAWC due to the inability of water and plant roots to penetrate the dense clay subsoil. **Lebanon** and **Villafranca** have a deeper rooting depth than **Heyford** but even at the maximum rooting depth their PAWC only approximates a shallow (600 mm deep) cracking clay. The maximum PAWC of 130 mm estimated for **Clarkei** assumes that the non-sodic clay subsoil encountered during sampling continues to at least 900 mm depth. This may be an overestimate as the clay subsoil may become sodic where it continues to greater depth.

Table 20. The plant available water capacity (mm) estimated for the major soils at Kilcummin

Soil	Effective rooting depth (mm)	PAWC (mm)
Soils overlying Devonian-Carboniferous rocks		
Violet	100-300	20-50
Soils overlying Permian sedimentary rocks		
Cherwell	100-600	20-90
Clarkei	50-900	10-130
Heyford	400	60
Soils overlying Tertiary volcanic and pyroclastic rocks		
- acid to intermediate volcanic rocks		
Commissioner	50-300	10-55
- basalt and pyroclastic rocks		
Cheeseboro	20-400	5-75
Russell	400-900	75-140
Falkner	500-900	90-135
Niagara	900	135
Rankin	900	130
Dickson	500-900	85-130
Kenlogan	450-900	85-140
Soils overlying Cainozoic limestone		
Windradene	20-400	5-75
Yackadoo	100-300	25-75
Aroa	600-900	100-145

Table 20. (continued)

Soil	Effective rooting depth (mm)	PAWC (mm)
Soils overlying Cainozoic ferricrete and weathered sediments		
Lebanon	700-900	95-110
Villafranca	500-900	80-110
Ok	900	130
Soils overlying Cainozoic gravelly sediments		
Winvic	80-500	25-80
Apron	400-900	70-120
Soils overlying Cainozoic clay sediments		
- elevated, level plains to undulating rises		
Eleanor	900	135
Eleanor, mottled phase	800	125
Holding	900	135-140
Diamond	800	130
Manar	900	125
Vicenza	900	130
Martyr	800-900	120-125
Kenmar	400-900	75-125
Kenmar, melonhole phase	900	120-125
Midden	900	125-135
Well	900	135
- low-lying level plains and footslopes		
Diamond, footslope variant	800	125
Well, footslope variant	300	55
Maraconda	200-600	40-100
Nungaroo	500-900	80-125
Soils overlying Quaternary alluvium		
Moramana	900	135
Moramana, gilgai phase	900	140
Solferino	500	90
Jeffray	500	90
Cattle	900	135
Fletcher	900	125

8.4.9 Plant nutrients in the surface soil

The general fertility ratings of Bruce and Rayment (1982) are given for soil bulk surface samples in Table 21. Sites that have been cleared, sown to improved pastures or cultivated have been included with sites in the virgin state. No fertiliser has been applied to any of the disturbed sites but those with sown pastures or being cultivated have not been included in the data for organic carbon and total nitrogen.

Table 21. Summary of the plant nutrient status of Kilcummin soil groups[a]

Soil group	Extractable					Organic carbon[c]	Total nitrogen[c]
	Phosphorus[b]	Potassium	Copper	Zinc	Manganese		
Soils overlying Devonian-Carboniferous rocks	very low	medium	low	low	medium	low	low
Soils overlying Permian sedimentary rocks	very low	medium	low to medium	low to medium	medium	low	very low to low
Soils overlying Tertiary volcanic and pyroclastic rocks							
- acid to intermediate volcanic rocks	medium	high	medium	medium	medium	medium	medium
- basalt and pyroclastic rocks	very low to high	high to very high	medium	low to medium	medium to high	low to medium	low to medium
Soils overlying Cainozoic limestone	very low to high	medium to very high	medium	very low to low	medium	low to medium	low to medium
Soils overlying Cainozoic ferricrete and weathered sediments	very low to low	medium to high	medium	very low to medium	medium to high	low	very low
Soils overlying Cainozoic gravelly sediments	medium to high	high	medium	medium	medium	low to medium	low
Soils overlying Cainozoic clay sediments							
- elevated, level plains to undulating rises	very low to high	low to very high	medium	very low to low	medium	low	very low to low
- low-lying level plains and footslopes	very low to low	very low to medium	medium	low to medium	medium to high	low	very low to low
Soils overlying Quaternary alluvium	very low to medium	medium to very high	medium	very low to low	medium to high	low to medium	low to medium

[a] Based upon ratings of Bruce and Rayment (1982) for bulk surface samples
[b] Bicarbonate extractable phosphorus
[c] Data for sites being cultivated or with sown pastures have not been included for organic carbon and total nitrogen

Bicarbonate extractable phosphorus levels are very low to low (≤20 mg/kg) in the soils overlying Devonian-Carboniferous rocks, Permian sedimentary rocks, Cainozoic ferricrete and weathered sediments, and in the soils on low-lying level plains and footslopes overlying Cainozoic clay sediments. The remaining soil groups have phosphorus levels varying between very low and high.

Extractable potassium levels are medium to very high (≥0.2 m.equiv./100 g) on all soil groups except **Eleanor, mottled phase** and the soils on low-lying level plains and footslopes overlying Cainozoic clay sediments. The extractable potassium levels are closely related to the exchangeable potassium levels in the surface (see section 8.4.5). Extractable copper levels are medium (0.3-5 mg/kg) in all soils except **Cherwell**, **Violet** and **Clarkei**, with levels in **Commissioner** and **Lebanon** being borderline between low and medium. Manganese levels are medium to high (2-500 mg/kg) in all soils. Extractable zinc levels are rated as low to very low (≤0.8 mg/kg if pH>7, or ≤ 0.5 mg/kg if pH<7) in most soils except for the medium levels recorded in **Cherwell**, **Heyford**, **Commissioner**, **Dickson**, **Ok**, **Winvic**, **Apron** and in the melonhole gilgai depression of **Nungaroo**.

Organic carbon is low to medium (0.5-2.5%) in all soils although high levels were recorded in some sites that have sown pastures. Levels in total nitrogen follow a similar trend with the majority of soils being very low to low (≤.15%).

9. Land degradation

9.1 Soil erosion

The extent of accelerated soil erosion was assessed at field inspection sites during the course of the survey. The severity of any sheet, rill and gully erosion was recorded as well as the depth of eroding gullies, where possible.

Assessments are highly subjective and are not an accurate measurement of erosion status for they are strongly dependant upon climate and management practices prior to inspection. Lowered stocking rates and improved growing season conditions can result in increased ground cover in grazing lands which often hides evidence of sheet erosion. Recent cultivation in cropping lands can easily mask both sheet and rill erosion. Nevertheless, the information provides an indication of the erosion status at the time of inspection. It does not indicate the susceptibility or erosion hazard of particular lands and further assessments would be required to show any trend in accelerated erosion over time.

The survey data are summarised in Table 21. The bulk of the lands having no effective disturbance other than grazing were in a stable condition with no evidence of erosion. The small proportion of sites that exhibit some form of erosion represent a wide range of soils although approximately half of these sites are situated on clay soils with Queensland bluegrass downs and eucalypt open woodlands to woodlands.

Erosion was also observed in a small proportion of lands partially to completely cleared for pastures. The percentages of sites with either sheet, rill or gully erosion are similar to the figures for lands with no effective disturbance and a wide range of soils is also involved. The only exception is that lands with partial clearing have a higher percentage of site with sheet erosion. This may be related to the larger proportion of sloping soils with hard setting and flaking surfaces in these sites.

Erosion is much more prevalent in the cultivated lands with sheet erosion recorded in almost one half, and rill erosion in one third, of the sites. Observations of gully erosion were also slightly higher than in the other lands. This extensive erosion of cultivated lands is a major concern as it threatens their long-term viability through loss of the fertile surface soil and reduced soil depth causing reduced PAWC.

Severe roadside erosion was also observed in some areas of **Heyford** and **Lebanon** soils. Deep, actively eroding gullies have been initiated where construction of diversion drains and loss of surface soil from tracks have exposed the clay subsoils.

All the eroding gullies observed were less than 1.5 m deep except for those created by roadside diversion drains which were up to 3 m deep.

Tunnel erosion also occurs at one location along the Moranbah to Blair Athol railway line where the strongly sodic and magnesium rich buried clays below **Rankin** soil are exposed in the wall of a cutting.

Table 22. The extent of erosion observed in the Kilcummin region

Disturbance	Percentage of field inspection sites with-					
	Sheet erosion		Rill erosion		Gully erosion	
	nil	minor to moderate	nil	minor to moderate	nil	minor to moderate
No effective disturbance (some cattle grazing)	93.0	7.0	96.0	4.0 [b]	97.9	2.1
Limited to extensive clearing	87.1	12.9 [a]	96.5	3.5	96.1	3.9
Complete clearing to pasture (may have been cultivated)	92.1	7.9	97.9	2.1	97.9	2.1
Cultivation	46.4	53.6	67.4	32.6 [b]	94.9	5.1

[a] This figure includes 1.5% of sites assessed as having severe sheet erosion

[b] These figures include 0.2% of sites assessed as having severe rill erosion

9.2 Secondary salinity

Irrigation is restricted to a few hundred hectares on Rugby station in the north-east of the region and secondary salinity as a result of this development has not occurred to date.

There is also no known dryland salting in the Kilcummin region. Small, sporadic occurrences of secondary seepage salting occur elsewhere in the basalt landscapes of Central Queensland (Hughes 1979). One outbreak of salting due to natural seepage within the clay soils overlying Cainozoic sediments has been reported by a landholder within the Kilcummin area. Both landscapes form a substantial source of salt and have potential for secondary seepage salting. Therefore, it is likely other small, isolated patches of dryland salting already occur in these landscapes in the Kilcummin region.

10. Land evaluation

10.1 Land suitability classification

Rainfed cropping and grazing beef cattle are the present land uses in the Kilcummin area (see section 2.2) and represent the only agricultural uses that appear to be economically viable in the long-term. Therefore, the agricultural potential of the study area was assessed for both rainfed cropping and beef cattle grazing with a land suitability classification being developed for each land use. The two classifications allocate land into one of five possible classes based on its potential to attain optimum production with minimal long-term degradation.

The classes are described as:

Class 1 **Suitable land with negligible limitations** and is highly productive requiring only simple management practices to maintain economic production

Class 2 **Suitable land with minor limitations** which either reduce production or require more than simple management practices of Class 1 to maintain economic production

Class 3 **Suitable land with moderate limitations** which either further lower production or require more than those management practices of Class 2 land to maintain economic production

Class 4 **Marginal land with severe limitations** which make it doubtful whether the inputs required to achieve and maintain production outweigh the benefits in the long-term

Class 5 **Unsuitable land with extreme limitations** that preclude its use

Land is considered less suitable as the severity of limitations for a land use increase. Increasing limitations may reflect either (a) reduced potential for production, and/or (b) increased inputs to achieve an acceptable level of production and/or (c) increased inputs required to prevent land degradation. The first three classes are considered suitable for a specified land use as the benefits from using the land for that use should outweigh the inputs required to initiate and maintain production. For the Kilcummin area, the benefits from using Class 4 land probably approximate the inputs required and its long-term suitability for the specified land use is doubtful. In contrast, there is no doubt regarding the long-term suitability of Class 1-3 lands or the unsuitability of Class 5 land. Class 5 land has limitations that in aggregate are so severe that the benefits would not justify the inputs required to initiate and maintain production.

The classifications are developed for the prevailing economic and technological conditions and if these conditions change then the classifications must be altered.

10.2 Suitability for rainfed cropping

The suitability classification evaluates the broadacre potential of land to grow rainfed sorghum, sunflower, wheat, safflower, cotton, chickpeas and annual fodder crops (sorghum, millet and oats). These crops are often grown in sequence with the actual crops being planted dependant upon rainfall. Their agronomic and management requirements were considered similar enough not to warrant separate classifications of individual crops. Maize was not included as it was considered not climatically adapted to the area due to its high susceptibility to moisture stress (Spackman and Foreman 1988).

10.2.1 Limitations to cropping

Eleven limitations were identified as being factors that significantly affect rainfed cropping in the Kilcummin area.

Water availability (m). Water is an essential requirement for crop growth. The water regime of a crop is determined initially by the climate of the area which dictates water input through rainfall and also determines crop requirements through evaporation, temperature and radiation. The soil modifies these patterns by storing and subsequently providing water to the crop as required.

The proportion of water stored in the soil that is available for crop growth (soil PAWC) has been estimated in Table 20, assuming a maximum root zone of 900 mm depth. Shields (1984) used similar data in a water balance model to show that a cropping success of approximately 75% is the maximum that can be attained in climatic conditions similar to Kilcummin. (A crop was defined as successful if its actual evapotranspiration was at least 51% of the potential rate required for optimum flowering and seed filling.) On this basis all land in the study area was considered to have a water availability limitation of some degree (m_2-m_5) with the severity of the limitation increasing as the soil PAWC decreases (Table 23). Soils with less than 100 mm PAWC were given either an m_4 or m_5 limitation with an arbitrary split at 75 mm.

The benchmark values used to differentiate m_2, m_3, m_4, and m_5 limitations correspond to cracking clays with 900, 600 and 400 mm depth of active root zone, respectively.

Table 23. Criteria used to determine the water availability limitation for rainfed cropping

Limitation level	PAWC (mm)	Predicted cropping success[a] (%)
2	≥130	70-75%
3	100-130	40-70%
4	75-100	<40%
5	<75	<<40%

[a] From water balance model results of Shields (1984)

For some soils the depth of active root zone and abundance of coarse fragments vary widely and their water availability limitation varies accordingly.

Nutrient deficiency (n). Soil nutrient deficiency has not been recognised as a problem for crop production on the traditionally cultivated soils of the Central Highlands. In a recent review, Lawrence (1988) mentions that only 15% of grain farmers in the region regularly use fertilisers, mainly nitrogen and phosphorus. As well, very few trial sites have given significant grain yield responses to nitrogen and phosphorus application although sorghum responses have been demonstrated recently on cracking clays north-east of Kilcummin (G.A. Lambert personal communication). Most crop responses to fertiliser application apparently occur on the traditionally cultivated soils (clays) and depend largely on fallow length and soil moisture status. Mineralisation of organic nitrogen is suspected of playing a major role in maintaining soil nitrate levels, particularly with summer crops (Lawrence 1988). Similarly, soil mycorrhiza may play an important role in maintaining phosphorus supplies to sorghum in soils with low phosphorus levels (Hibberd *et al.* 1986).

Soil nutrient levels for the Kilcummin soils are compared in section 7.4 with threshold limits set as guidelines by Consolidated Fertilisers Limited (1984) for determining crop deficiency. According to these guidelines, the majority of clay soils have adequate levels of most nutrients except zinc. (The extractable zinc levels are low to very low and either approximate or fall below the threshold limits in all Kilcummin soils except **Dickson, Ok, Winvic, Apron** and in the depression of **Nungaroo**.)

Almost all of the clays that are cultivated are not fertilised and significant yield differences due to nutrient deficiency have not been observed in the Kilcummin area (H. J. Chamberlain personal communication). Therefore, the majority of clays have been given a negligible nutrient deficiency limitation (n_1). Nutrient levels are expected to run down eventually in these soils under continuous cultivation and application of fertilisers will be required. Several clay soils have lower inherent phosphorus and potassium levels than the majority, generally below the threshold limits, and have been assigned a slight limitation (n_2). The remaining duplex soils, red earth and shallow sands and loams have low inherent levels of several nutrients including nitrogen, phosphorus, calcium and zinc. These soils have been given either a moderate (n_3) or severe (n_4) limitation.

Soil physical factors (p). The high evaporation rates in the Central Highlands necessitate crop seeds being planted with sufficient contact with moist soil to prevent desiccation prior to germination and establishment. This requirement is critical for summer crops. The condition of the surface soil may reduce plant establishment by either failing to maintain adequate seed contact with moist soil or by providing a barrier to seedling emergence.

Spackman (1985) has documented evidence in a review on this subject to show that surface soils with a fine aggregate size give better establishment than those with a coarse aggregate size. This may be the result of finer aggregates having tighter packing and providing a greater surface area of moist soil contact with seed as well as having lower evaporation due to finer air spaces.

Plant establishment rate is higher on the finer self-mulching clay soils than on the coarser self-mulching clays (H. J. Chamberlain personal communication). The clays with very fine self-mulching surfaces are mainly associated with brigalow, gidgee and boree scrub while the coarser self-mulching clays generally occur under downs and associated eucalypt open woodlands to woodlands. However, areas of **Moramana** soil along Logan Creek with eucalypt vegetation also have a very fine self-mulch while the scrub soils with melonhole gilgai frequently have a coarser self-mulching surface in depressions. The soils with very fine self-mulching surfaces are considered to have negligible physical limitations to plant establishment (p_1).

Several scrub soils with prominent gilgai frequently have firm to hard setting surfaces on the mounds. Following cultivation, these surfaces impede seedling emergence but the restriction is considered minor. Where the associated depressions have a very fine self-mulch the overall soil physical limitation is still considered negligible (p_1) but a minor limitation (p_2) has been assigned to soils with a combination of firm to hard setting mounds and coarser self-mulch in depressions.

Apart from **Moramana**, the majority of clays under downs and eucalypt vegetation have been given a minor limitation (p_2). **Diamond, footslope variant** and **Falkner** have a generally coarser self-mulch and have been assigned a moderate limitation (p_3). **Well, footslope variant** is a scrub soil with a similar self-mulch and has also been given a moderate limitation. The coarse self-mulch of **Maraconda** and **Well, sandy surface variant** severely limits (p_4) plant establishment.

Hard setting clay loam to sandy loam surfaces provide a barrier to seedling emergence and soils with this attribute have been given a moderate limitation (p_3). An exception is the surface condition

of **Cherwell** which varies from soft to hard setting but generally provides only a negligible limitation (p_1) to plant establishment.

Soil compaction may also limit crop production. Most clay soils are susceptible to compaction but the problem is considered minor at Kilcummin as it can be overcome by adjusting cultivation patterns and by reducing wheel pressure or using crawler tracks on tractors. At present, it is not possible to determine which soils are the most susceptible and, therefore, this aspect has not been considered as part of the soil physical limitation.

Soil workability (k). Cultivation is necessary for seedbed preparation and planting and is also used for weed control. Soil workability refers to the suitability of land for cultivation based upon physical attributes of the soil. The major soil physical attributes affecting workability are strength, moisture range and abrasiveness. Soil strength is the resistance of a soil to breaking or deformation (McDonald and Isbell 1984) and the greater the strength the more difficult it is to cultivate.

Moisture range refers to the appropriate range in moisture content over which a soil can be successfully cultivated. Some soils can be worked at any moisture content while others can only be worked over a narrow moisture range. Timing of cultivation is critical for planting operations (especially summer crops) at Kilcummin. The high evaporation rates mean that many surface soils dry quickly leaving only a minimal time period for broadacre planting. Even soils which can be worked over a relatively wide moisture range may have a significant soil workability limitation due to this minimal time period available for planting large areas. These soils tend to be the coarser textured clay loams to sandy loams which are also more abrasive on cultivation implements than clays.

All clay soils have only a narrow moisture range appropriate for cultivation but farmer experience at Kilcummin indicates that the very fine self-mulching clays with scrub vegetation are generally easier to work than the clays with downs and associated eucalypt open woodlands to woodlands. Soil strength in the plough zone appears less and the soils remain within the appropriate moisture range for a longer period than the clays with downs and eucalypt vegetation. These very fine self-mulching clays with scrub vegetation are considered to have a negligible soil workability limitation (k_1). The highly calcareous soil **Windradene** has also been given a negligible limitation.

The majority of clays with downs and eucalypt vegetation have been given a minor limitation (k_2), as has **Well, footslope variant**, a clay with scrub vegetation but with similar physical attributes. Clay soils with scrub vegetation and mainly melonhole gilgai can have wide variation in moisture content between mounds and depressions following rainfall. This restricts the timing of planting to a period when depressions are sufficiently dry and mounds still retain sufficient moisture for planting. These soils have been given a minor limitation. The coarser textured **Cherwell** soil does not impede cultivation to any degree and could be worked over a wide moisture range but the surface soil dries out rapidly and provides only a limited period for broadacre planting. It has been given a minor limitation as well.

Maraconda and **Well, sandy surface variant** are clay soils with considerable soil strength and a narrow moisture range for cultivation. Cultivation is impeded on these soils even when worked at the appropriate moisture content and they have been given a moderate limitation (k_3). The soils with hard setting sandy loam to light clay surface soils provide some impedance to cultivation and also have a very narrow moisture range for planting due to rapid drying on the surface soil. These soils have also been given a moderate limitation.

Salinity (sa). Salinity refers to the presence of soluble salts in soils. High levels of soluble salts may result in reduced plant productivity. Salinity may be an inherent attribute of the soil and may also occur as the consequence of agricultural practices or clearing of native vegetation.

Inherent salinity of the Kilcummin soil profile classes has been discussed in section 8.4.2. Shaw *et al.* (1987) have tabulated yield responses to salinity for a range of plants including the main crops grown at Kilcummin. Salinity is expressed as EC_{SE} in these tables, thus enabling the expected yield responses to be compared with soil EC_{SE} values given in Table 17 for the major Kilcummin soils. However, the method used to estimate soil EC_{SE} values may be inappropriate for Kilcummin soils (see section 8.4.2) and the degree of yield reduction for particular soils varies markedly depending on whether an average or weighted profile value is used. The weighting method may be inappropriate for conditions at Kilcummin. The $Cl_{1:5}$ data has therefore been used to determine whether a salinity limitation exists.

The yield response tables of Shaw *et al.* (1987) indicate a similar salinity threshold for the crops commonly grown at Kilcummin. The threshold, at which crops would suffer a 10% yield decline, is equiavlent $Cl_{1:5}$ values of 0.14 to 0.175% in soils with 60% clay content. These figures appear too high as local knowledge of crop behaviour in the field suggests yields are affected once levels attain 0.06 to 0.08%. The soils at Kilcummin are considered to have a salinity limitation of some degree if their average profile $Cl_{1:5}$ exceeds 0.06%.

Yield reductions due to salinity are anticipated on **Well, footslope variant**, **Maraconda**, **Solferino** and the depressions of **Nungaroo**. The $Cl_{1:5}$ levels reach 0.06% between 200 and 400 mm depth in **Well, footslope variant** and **Maraconda**, and at 500 mm depth in the depressions of **Nungaroo**. **Maraconda** and **Well, footslope variant** have been assigned a moderate limitation (sa_3); and the inherent salinity of **Nungaroo** is considered to provide a minor limitation (sa_2) to cropping. The **Solferino** profile is thought to represent only isolated sites with restricted drainage that occur within the Tertiary basalt landscape and the chloride level across the majority of the area is considered to be similar to the level of **Moramana** (see section 8.4.2). The sites with restricted drainage that are likely to have high chloride levels cannot be reliably predicted at present. As a result, **Solferino** UMAs have not been assigned a significant salinity limitation, but isolated saline areas may occur. Similar areas may also occur in **Moramana** UMAs within the Tertiary basalt landscape.

Vicenza has average profile chloride ranging from below 0.06% to marginally above this level (Table 17). Chloride levels are There may be a minor reduction in crop yield on some areas of this soil but there will not be consistent yield reduction across all areas. The **Kenmar** depression profile also has chloride levels above 0.06% but the depressions of both **Kenmar, melonhole phase** and **Midden** have very low levels. The three soils are morphologically similar, overlie similar materials and occupy similar landscape positions. **Vicenza** and **Kenmar** are considered to have only a negligible salinity limitation (sa_1).

Well, sandy surface variant occurs on the low-lying clay plains bordering the elevated plains and undulating rises. There is no analytical data available for this soil but its profile salinity is expected to be similar to that of **Maraconda** and **Well, footslope variant** which occur upslope and downslope, respectively (Fig. 6). **Well, sandy surface variant** has been assigned a similar, moderate limitation.

Analytical data from several deep cores drilled in the elevated plains and undulating rises overlying Cainozoic clay sediments reveal high levels of soluble salts (0.1-0.3% chloride) between 1 and 3 m depth. With a change in land use from native pastures to rainfed cropping there is potential for greater water movement through the landscape and for dryland seepage salting. A

landholder has reported one outbreak of such secondary salinity on the footslopes of the elevated plains and undulating rises. **Diamond, footslope variant** has been given a minor salinity limitation on this basis even though its inherent chloride levels are below the level considered as significant.

The remaining soils have only very low to medium chloride levels and have been given a negligible limitation.

Rockiness (r). Rockiness refers to rock outcrop and coarse fragments (McDonald *et al.* 1984b) within the plough zone that impede cultivation and damage machinery. The effects of rockiness on properties such as infiltration, soil water storage and erodibility are covered in other limitations. The degree of rockiness limitation is directly related to the proportion of rock outcrop and will also vary with the size, quantity and hardness of coarse fragments within the plough zone.

Farmer experience at Kilcummin suggests that gravel (up to 60 mm diameter) does not significantly impede cultivation. The rockiness limitation is therefore based on the proportion of cobble, stone and boulders (>60 mm diameter) and rock outcrop within the plough zone of a UMA. The boundaries between negligible, minor, moderate, severe and extreme rockiness were arbitrarily chosen. A UMA with approximately 10% or less cobble, stone, boulders or rock outcrop was considered as having a negligible limitation (r_1); at least 50% rockiness cover (approximate) was assigned either a severe (r_4) or extreme limitation (r_5), depending on the amount of cover. The levels of rockiness that constitute a minor (r_2) or moderate (r_3) limitation were subjectively interpolated between these levels for each UMA.

The majority of soils are free of rock outcrop and contain very few (none to less than 10%) large coarse fragments. All UMAs dominated by these soils have a negligible limitation, but a proportion of the UMAs containing **Cheeseboro, Falkner, Russell, Niagara, Clarkei, clay surface variant** and **Dickson, shallow variant** as the dominant soil have a significant rockiness limitation ($r_{2\text{-}5}$). As well, every UMA with **Violet, Cherwell, Commissioner, Winvic, Yackadoo, Russell, stony phase** and **Ok, gravel phase** as the dominant soil has a significant rockiness limitation.

Microrelief (g). Microrelief refers to relief up to a few metres about the plane of the land surface (McDonald *et al.* 1984b). The microrelief limitation covers the effect microrelief has on causing uneven cultivation and impeding trafficability of machinery. Features such as high soluble salts in mounds, coarse self-mulch and ponding in depressions can be associated with gilgai microrelief but are covered in the salinity (sa), physical (p) and wetness (w) limitations.

Gilgai are the only form of microrelief that occur at Kilcummin. Normal, linear and lattice gilgai have a vertical interval of approximately 0.3 m or less and present only a negligible limitation (g_1) to the use of machinery but melonhole gilgai, with a vertical interval greater than 0.3 m, can impede cultivation and trafficability. The degree of limitation depends upon the amplitude of vertical interval and relative proportion of mounds, depressions and flat areas within a UMA.

Kenmar, melonhole phase and **Midden, melonhole phase** have melonhole microrelief with vertical intervals between 0.3 m and 1.3 m. All the UMAs dominated by these soils have quite dense mounds and depressions with few flat areas and have been given a moderate microrelief limitation (g_3). The vertical interval of **Nungaroo** is less (0.15-0.6 m) but the density of mounds and depressions is high in UMAs dominated by this soil and they have also been given a moderate limitation. **Manar** soil generally has normal gilgai but two UMAs have melonhole gilgai and have been assigned a moderate limitation as well. The remaining soils and UMAs have been assigned a negligible microrelief limitation.

Wetness (w). The wetness limitation takes into account the adverse effects of excess water on crop production through reduction in plant growth and yield, and restrictions on the use of machinery following rain. Wetness refers to excess water on the soil surface and in the profile as a direct result of rainfall or run-on from adjacent land. The excess water can occur due to poor soil permeability, restricted surface drainage or a combination of both. This is in contrast to flooding which, in this report, refers to excess water as a direct result of stream channel overflow.

An excess of water occurs intermittently at Kilcummin in all clay soils, except probably the brightly coloured red and brown clays. This is only a short-term problem on most soils but can cause denitrification due to anaerobic soil conditions with some subsequent loss of yield. It is most common following heavy winter rainfall when evaporation rates are low. More frequent and prolonged wetness occurs on soils of the low-lying level plains (**Maraconda** and **Nungaroo**), on low-lying parts of the alluvial plains (**Cattle, Jeffray** and some UMAs dominated by **Fletcher, Moramana and Moramana, gilgai phase**) and in melonhole gilgai depressions (**Kenmar, melonhole phase** and **Midden, melonhole phase**). These UMAs have been given a minor wetness limitation (w_2) while all other soils have been given a negligible limitation (w_1).

Water erosion (e). Rainfed cropping generally increases the potential for soil loss from rainfall and subsequent run-off compared to land with little effective disturbance. The accelerated soil loss is due to an increased volume of run-off, increased velocity of water flow and decreased protection of the soil surface when devoid of vegetation. The result is declining productivity, increasing difficulty to cultivate and, eventually, an inability to produce a crop in most years. Thus, only land that can sustain rainfed cropping in the long-term is considered suitable for that use.

Accelerated soil loss is a product of the climate, landform, soil properties, vegetative cover and management practices for any one area. The water erosion limitation was determined for each UMA using a combination of landform and soil attributes as criteria. The criteria were set for the climate at Kilcummin assuming that the current QDPI recommendations for vegetative cover and management practices are adopted. The potential for soil loss by water erosion will be greater if these recommendations are not followed. The landform and soil attributes used as criteria for determining the water erosion limitation are indicated in Table 24.

Water erosion was considered a negligible limitation (e_1) on all UMAs, regardless of the dominant soil, where slopes are mainly less than 0.5%. The remaining UMAs (with slopes of 0.5% and greater) have a limitation of some degree (e_2-e_5).

Flooding (f). Land periodically inundated by water from stream channel overflow has a flooding limitation. Flooding can cause damage due to both fast flowing water and submersion by standing water. Submersion by standing water can deprive plants of oxygen and deposit sediment in growing points, thereby reducing their productivity. Fast flowing floodwaters can flatten a crop, cause stream bank erosion and remove topsoil from one location and deposit the material, along with extraneous objects such as rocks and logs, in other locations. This can result in plants being dislodged, having roots exposed, or being covered with sediment. All these effects are covered by the flooding limitation.

The severity of flooding as a limitation depends upon the frequency, duration, depth and velocity of floodwaters. Such quantitative data is not available for Kilcummin and the limitation has been determined on the basis of local knowledge. The flooding frequency is rarely more than 1 in 5 years and flood velocity is generally low on inundated land. **Fletcher, Jeffray, Moramana, Solferino** and the **Miscellaneous soils** have been given a minor flooding limitation (f_2) along with some UMAs dominated by **Moramana, gilgai phase, Windradene** and **Midden, melonhole phase**. The UMAs

with mainly **Cattle** soil have anastomosing stream channels which have been taken as indicators of more frequent and possibly faster flowing floods. These UMAs have been assigned a moderate limitation (f_3) while the remaining UMAs have a negligible limitation (f_1).

Table 24. Criteria used for determining the water erosion limitation for rainfed cropping

Limitation level	Landform attributes	Soil
1	level plains (most slopes <0.5%)	all soils
2	level plains (most slopes 0.5-1%)	clays without melonhole gilgai; Apron; Dickson, shallow variant; Villafranca; Winvic; Yackadoo
	gently undulating plains and rises (slopes 1-3%)	clays with melonhole gilgai
3	gently undulating plains and rises (slopes 1-3%)	clays without melonhole gilgai; Apron; Commissioner; Dickson, shallow variant; Violet; Winvic; Yackadoo
4	gently undulating rises to undulating low hills (most slopes 2-7%)	clay soils; Clarkei, clay surface variant; Dickson, shallow variant; Ok, gravel phase; Violet; Windradene
5	undulating rises to very steep hills and plateau remnants (most slopes >3%)	Clarkei; Clarkei, clay surface variant; Commissioner; Cherwell
	level to gently undulating plains and rises Miscellaneous soils (most slopes >0.5%)	Heyford; Lebanon; Lebanon, red variant;

Topography (t). Topography affects the use of machinery for cultivation and harvesting operations. The large machinery used for broadacre cropping is more efficient on extensive areas of level ground and on gentle, planar slopes. Level land with abundant gullies or undulating land with its crests, uneven slopes and associated gullies is less suitable for the use of machinery. A topography limitation exists wherever gully dissection and/or steep, complex slopes and crests significantly increase the difficulty of cultivation and harvesting.

A minor (t_2) to moderate (t_3) topography limitation has been given to all UMAs with a flooding limitation or dominated by **Nungaroo** soil due to their dense dissection by gullies. A few UMAs with mainly **Diamond** soil and **Diamond, footslope variant** have also been assigned a minor to moderate limitation. All the UMAs with **Clarkei, Cherwell** and **Clarkei, clay surface variant** have been given a extreme limitation (t_5) due to intense gully dissection combined with steep, complex slopes. The remaining UMAs have been considered to have a negligible topography limitation (t_1).

10.2.2 Suitability results

The severity of all relevant limitations as well as the resultant suitability class are recorded for every UMA on the UMA data file and are summarised in Table 25 for each mapping unit.

Table 25. Land suitability limitations and classes for rainfed cropping assigned to each mapping unit

Mapping unit	Limitations	Class
Apron	$m_4\ n_2\ p_3\ k_3\ e_{2-4}$	4
Aroa	$m_{2-4}\ p_2\ k_2\ e_{2-3}$	2-4
Cattle	$m_3\ w_2\ f_3\ t_{2-4}$	3-4
Cheeseboro	$m_5\ p_2\ k_2\ r_{1-5}\ e_{2-4}$	5
Cherwell	$m_5\ n_4\ k_2\ r_4\ e_5\ t_5$	5
Clarkei	$m_5\ n_3\ p_3\ k_3\ e_5\ t_5$	5
Clarkei, clay surface variant	$m_4\ n_2\ p_3\ k_3\ r_{1-4}\ e_{4-5}\ t_5$	5
Commissioner	$m_5\ n_4\ p_3\ k_3\ r_5\ e_{2-5}$	5
Diamond	$m_2\ p_2\ k_2\ e_{2-4}\ t_{1-3}$	2-4
Diamond, footslope variant	$m_{3-4}\ n_2\ p_3\ k_2\ sa_2\ e_{2-4}\ t_{1-2}$	4
Dickson	$m_4\ p_3\ k_2\ e_{2-3}$	4
Dickson, shallow variant	$m_5\ p_2\ k_3\ r_{1-5}\ e_{2-4}$	5
Eleanor	$m_2\ p_2\ k_2\ e_2$	2
Eleanor, mottled phase	$m_2\ n_2\ p_2\ k_2\ e_2$	3
Falkner	$m_{3-4}\ p_3\ k_2\ r_{1-3}\ e_{2-3}$	3-4
Fletcher	$m_3\ n_2\ p_{2-3}\ k_3\ w_{1-2}\ f_2\ t_{2-4}$	4
Heyford	$m_4\ n_3\ p_3\ k_3\ e_5$	5
Holding	$m_2\ p_2\ k_2\ e_3$	3
Jeffray	$m_3\ p_2\ k_2\ w_2\ f_2\ t_{2-3}$	4
Kenlogan	$m_{2-3}\ p_{1-2}\ k_{1-2}\ e_{2-3}$	3
Kenmar	$m_3\ e_{2-3}$	3
Kenmar, melonhole phase	$m_4\ p_2\ k_2\ g_3\ w_2$	4
Lebanon	$m_4\ n_3\ p_3\ k_3\ e_5$	5
Lebanon, red variant	$m_4\ n_3\ p_3\ k_3\ e_5$	5
Manar	$m_2\ g_{1-3}\ w_{1-2}\ e_2$	2-3
Maraconda	$m_4\ n_2\ p_4\ k_3\ sa_3\ w_2$	5
Martyr	$m_3\ p_{1-2}\ k_{1-2}\ e_{2-3}$	2-3
Midden	$m_3\ p_{1-2}\ k_{1-2}\ e_3$	3
Midden, melonhole phase	$m_4\ p_2\ k_2\ g_3\ w_2\ e_{1-2}\ f_{1-2}\ t_{1-2}$	4
Miscellaneous soils	$m_4\ n_3\ p_3\ k_3\ e_5\ f_2\ t_4$	5
Moramana	$m_{2-3}\ p_{1-2}\ k_2\ w_{1-2}\ e_{1-3}\ f_2\ t_{2-4}$	2-4
Moramana, gilgai phase	$m_{2-3}\ p_2\ k_2\ w_{1-2}\ e_{1-3}\ f_{1-2}\ t_{1-2}$	2-3
Niagara	$m_{2-4}\ p_{1-3}\ k_{1-2}\ r_{1-3}\ e_{2-3}$	2-4
Nungaroo	$m_4\ n_2\ p_3\ k_2\ sa_2\ g_3\ w_2\ t_{1-4}$	4
Ok	$m_3\ p_3\ k_3\ e_{3-4}$	4
Ok, gravel phase	$m_4\ p_3\ k_3\ r_2\ e_4$	4
Rankin	$m_2\ e_{2-3}$	2-3
Russell	$m_{2-4}\ p_2\ k_2\ r_{1-3}\ e_{2-4}$	2-4
Russell, gilgai phase	$m_{2-3}\ p_2\ k_2\ e_{2-3}$	2-3
Russell, stony phase	$m_3\ p_2\ k_2\ r_4\ e_2$	4

Table 25 (continued).

Mapping unit	Limitations	Class
Solferino	m_2 f_2 t_{2-4}	2-4
Vicenza	m_{2-3} e_2	2-3
Villafranca	m_4 n_4 p_3 k_3 e_2	5
Violet	m_5 n_4 p_3 k_3 r_{3-5} e_{3-4}	5
Well	m_2 e_{2-3}	2-3
Well, footslope variant	m_4 n_2 p_3 k_2 sa_3 e_{2-3}	4
Well, sandy surface variant	m_4 n_2 p_4 k_3 sa_3 e_2	5
Windradene	m_5 p_{1-2} e_{1-4} f_{1-2} t_{1-3}	5
Winvic	m_5 n_3 p_3 k_3 r_2 e_{2-3}	5
Yackadoo	m_5 n_3 p_3 k_3 r_2 e_{2-3}	5

No land is assigned to Class 1 (Table 26) because the entire study area has a water availability limitation of some degree but almost 155 000 ha or 54.3% of the area has been classified as suitable land for rainfed cropping with minor to moderate limitations (Classes 2 and 3).

The clay soils on level plains to gently undulating rises overlying Tertiary volcanic and pyroclastic rocks; the clay soils on elevated, level plains to undulating rises overlying Cainozoic clay sediments and on alluvial plains overlying Quaternary alluvium comprise almost all of this land. The deep clays without melonhole gilgai and with most slopes $<0.5\%$ constitute Class 2 land. The remaining 45.7% of the area was evaluated as being only marginal or unsuitable land for cropping.

Table 26. The proportion of land in each suitability class for rainfed cropping

Land suitability class	Proportion of study area	
	Area (ha)	% of total area
1	nil	nil
2	46 140	16.2
3	108 830	38.1
4	35 950	12.6
5	94 310	33.1
Total	285 230	100.0

The area of land affected by each limitation is given in Table 27. There is a water availability limitation for the entire area. Water erosion (e), soil physical factors (p) and soil workability (k) are other important limitations to production affecting 85%, 76% and 71% of the study area respectively. Soil nutrient deficiency (n) is a limitation to production on 30% of the area but the remaining limitations individually affect less than 20% of the study area. Soil workability (k), salinity (sa), microrelief (g), wetness (w) and flooding (f) occur as only minor to moderate limitations. However, the effect of each limitation in combination with others can render land marginal or unsuitable for rainfed cropping.

10.3 Suitability for beef cattle grazing

The beef cattle grazing suitability is assessed in terms of the potential to graze improved pastures. Class 1 to 3 land is considered suitable for grazing sown pastures and can thus attain maximum production levels. The plants best adapted to the Kilcummin area and are appropriate for sown pastures are buffel grass (*Cenchrus ciliaris*), rhodes grass (*Chloris gayana* cv. Katambora), green panic (*Panicum maximum* var. *trichoglume*), silk sorghum (*Sorghum halepense* x *S. roxburghii* x *S. arundinaceum*), purple pigeon grass (*Setaria incrassata*) and bambatsi panic (*Panicum coloratum* var. *makarikariense* cv. Bambatsi). Bambatsi panic is used mainly in wet areas where, except for purple pigeon grass, the other introduced grasses have a lower persistence. The range of suitable species and the available options for establishment decrease from Class 1 to 3.

Class 4 represents marginal land for grazing sown pastures. There are three possible subclasses within Class 4:

- land with native pastures of low productivity on which sown pastures can be successfully established but have doubtful long-term productivity;
- land on which a limited number of sown pastures can be established but has high quality native pastures;
- land with native pastures of low productivity that can be oversown with shrubby stylo legumes (*Stylosanthes* species).

Class 5 land is not suitable for extensive pasture improvement but is suitable for grazing native pastures of low productivity.

10.3.1 Limitations to grazing improved pastures

Ten limitations were identified as being significant for grazing improved pastures in the Kilcummin area.

Water availability (m). This refers to the limitation placed on total dry matter production of pastures by a restriction of soil water supply. The same factors govern soil water supply to pastures as for crops (see section 10.2.1). However, pasture production at Kilcummin is achieved from a shallower active root zone (generally less than 0.6 m) than required for crops and the pastures will attain maximum production with a lower soil PAWC. The water availability limitation for pastures is considered less severe than for crops for all but the very shallow soils.

Clay soils with at least 600 mm depth of active root zone were considered to have a negligible water availability limitation (m_1) for pasture production at Kilcummin. A minor to extreme limitation (m_2-m_5) was assigned to all other soils. The actual limitation level assigned to a soil was interpolated from the level determined for cropping, using the active root zone depth and soil texture as the basis for adjustment.

For some soils the depth of active root zone and abundance of coarse fragments vary widely and their water availability limitation varies accordingly.

Nutrient deficiency (n). The major limiting factor to beef production from pastures in northern Australia is pasture quality which, in turn, is governed principally by the availability of nitrogen and phosphorus (Winks 1984). Other nutrients with a prominent role in determining pasture productivity

include potassium and calcium.

Shields and Anderson (1989) have described the soil fertility status of grazing lands in Central Queensland in relation to pasture development options available. They showed that levels of bicarbonate extractable phosphorus and exchangeable cations (such as potassium and calcium) can be related to major land types. Fixation of phosphorus to forms unavailable for plant use was shown to be insignificant. Their data have been used as guidelines in determining the nutrient deficiency limitations of soils at Kilcummin but do not include assessments of available nitrogen.

The availability of nitrogen depends upon the amount of nitrogen contained in organic matter and the rate that it is mineralised into forms available for plant growth. Mineralisation occurs in a seasonal cycle but the annual rate is initially accelerated by clearing and sowing improved pastures, then generally slows after several years. This results in pasture run down is common to all soils at Kilcummin and can be overcome by various renovation methods. Pasture run down cannot be used to differentiate different soils and has not been considered as a criterion for nutrient deficiency. However, the level of nitrogen contained in organic matter provides an overall control on the amount of nitrogen available for plant growth and has been used as a criterion. Total nitrogen gives an indication of the amount of nitrogen in organic form and has also been used as an indicator of nutrient deficiency at Kilcummin.

Soil nutrient levels for the Kilcummin soils are compared in section 8.4. The soils with brigalow and gidgee scrub and the soils on alluvial plains overlying Quaternary alluvium generally have high levels of all nutrients. They are considered to have only a negligible nutrient deficiency limitation (n_1). **Dickson** has similar nutrient levels and has also been assigned a negligible limitation.

The majority of clay soils with downs or eucalypt vegetation have lower nitrogen levels and have been given a minor limitation (n_2). **Nungaroo** and **Well, footslope variant** have lower nitrogen and potassium levels than most of the clay soils with scrub vegetation and have also been assigned a minor limitation.

Maraconda, Diamond, footslope variant and **Eleanor, mottled phase** are clay soils with relatively low nitrogen, phosphorus and potassium levels and have been given a moderate limitation (n_3). **Well, sandy surface variant** was not sampled for analysis but is expected to have a similar nutrient deficiency. A moderate limitation has also been assigned to **Clarkei, Villafranca** and the duplex soils with eucalypt vegetation due to similar low levels of nitrogen and phosphorus. **Winvic** has slightly higher nutrient levels but is a shallow, gravelly soil from which some nutrients may be easily leached and has been given a moderate limitation.

The shallow, gravelly sands and loams have relatively low nutrient levels and have a potential for significant losses of some by leaching. These soils have been given a severe nutrient deficiency limitation (n_4).

Soil physical factors (p). This limitation refers to the restriction to establishment and spread of introduced pastures due to soil surface condition. As the soil surface condition becomes more limiting the available options for pasture introduction become fewer and any secondary spread becomes more difficult.

Pasture seeds can be sown into an ashbed but, if the vegetation cover is inadequate for producing sufficient ash, may also be sown directly onto and into the surface soil.

Buffel grass, rhodes grass and green panic have small seeds and are difficult to establish on the

coarser self-mulching clays under downs and eucalypt vegetation. A suitable ashbed cannot be produced from this vegetation and many of the small seeds are probably lost down large air spaces deep below the surface when sown directly onto the surface or into a cultivated seedbed. The seed remaining near the surface may desiccate rapidly due to high evaporation from the large air spaces and minimal seed contact with the bigger aggregates of moist soil. These problems of direct sowing onto and into coarser self-mulching clays are reduced for the larger seeded silk sorghum and purple pigeon grass.

All the introduced grasses can be readily established on the finer self-mulching clays with or without an ashbed. They can also be sown into a cultivated seedbed in hard setting surface soils but seedling emergence is less reliable. Secondary spread can be restricted by the hard setting surface of surface soils with sandy loam to clay loam textures (Cavaye *et al.* 1989).

In contrast, establishment and spread on the coarser textured, hard setting surfaces is not significantly restricted for the shrubby stylos which can be either broadcast onto the surface or sown at very shallow depth. This may be due to a very thin veneer of fine sand which is commonly present on these surfaces. However, establishment of these legumes on clay soils, whether self-mulching or hard setting, is very difficult.

At Kilcummin, the very fine self-mulching clays with scrub vegetation have the widest range of options available for establishment of improved grasses. The grasses also appear to spread easily on these soils. The only improved pastures difficult to establish are shrubby stylos but this is considered to be a negligible limitation due to soil physical limitations (p_1).

Several scrub soils have prominent gilgai which frequently have firm to hard setting clay surfaces on the mounds. Without an ashbed these surfaces may give some restriction to establishment and spread of introduced grasses. Where the associated depressions have a very fine self-mulching surface the overall soil physical limitation is still considered negligible but a minor limitation (p_2) has been assigned to soils with a combination of firm to hard setting mounds and coarser self-mulch in depressions.

The remaining scrub soils generally have hard setting, mainly clay, surface soils. Introduced grasses can be readily established in an ashbed although there is some restriction without an ashbed and it is difficult to establish stylos on these soils. They have been assigned a minor limitation. **Cherwell** has a soft to hard setting surface soil which does not significantly restrict grass and legume establishment but there is insufficient vegetation cover to produce a suitable ashbed. **Cherwell** has also been given a minor limitation.

Establishment of small seeded grasses is difficult on the coarser self-mulching clays and legume establishment is extremely difficult. Apart from **Maraconda**, those soils with downs and eucalypt vegetation have been given a moderate limitation (p_3). **Well, footslope variant** and **Well, sandy surface variant** have scrub vegetation which can produce a suitable ashbed but establishment and spread of grasses becomes difficult in the relatively coarse self-mulch once the vegetation is removed. These soils have been assigned a moderate limitation as well. The combination of insufficient vegetation to produce an ashbed and surface condition also result in a moderate limitation for the soils with hard setting surfaces and eucalypt vegetation.

Maraconda is a clay soil under downs and with quite coarse self-mulch. Establishment of even the large seeded grasses is extremely difficult on this soil and it has been assigned a severe limitation due to soil physical factors (p_4).

Salinity (sa). This limitation refers to the reduction in dry matter production and persistence of introduced species due to the presence of excess soluble salts in the soil. Salinity may be an inherent attribute of the soil and may also occur as the consequence of agricultural practices or clearing of native vegetation.

Inherent salinity of the Kilcummin soil profile classes has been discussed in Section 8.4.2. Shaw *et al.* (1987) have tabulated yield response to salinity for a range of plants including buffel grass, rhodes grass and green panic. Salinity is expressed as EC_{SE} in these tables, thus enabling the expected yield responses to be compared with soil EC_{SE} values given in Table 17 for the major Kilcummin soils. However, the method used to estimate soil EC_{SE} values may be inappropriate for Kilcummin soils (see section 8.4.2) and the relative salt tolerances calculated from Shaw *et al.* (1987) for crops appear much too high for the Kilcummin area (section 10.2.1). Their criteria for pastures may be similarly inappropriate and have not been used. The salinity limitation for pastures has been based upon $Cl_{1:5}$ levels in the soil. This approach assumes that Cl is the dominant anion contributing to salinity under field conditions.

The salinity limitations assigned to Kilcummin soils for rainfed cropping have been adjusted to allow for the fact that chloride levels increase with depth and most pasture plants grown at Kilcummin require a shallower active root zone to achieve satisfactory production (generally less than 600 mm depth) than crops require. As a result, **Maraconda** and **Well, footslope variant** have been given a minor salinity limitation (sa_2). There is no analytical data available for **Well, sandy surface variant** but its profile salinity is expected to be similar to that of **Maraconda** and **Well, footslope variant** which occur upslope and downslope, respectively (Fig. 6). **Well, sandy surface variant** has been assigned a similar, minor limitation.

The remaining soils have only very low to medium chloride levels and have been given a negligible limitation (sa_1).

Rockiness (r). Rockiness refers to rock outcrop and coarse fragments (McDonald *et al.* 1984b) within the plough zone that impede cultivation and damage machinery (see section 10.2.1).

Cultivation is occasionally required in sown pastures for preparation of a seedbed, for pasture renovation and for control of woody weeds. The depth of ploughing, especially for woody weed control, is similar to that required for cropping but the frequency of cultivation is considerably less. The criteria used to determine negligible, minor, moderate, severe and extreme rockiness at Kilcummin were therefore less stringent than those used to assess the rockiness limitation for cropping.

The majority of soils are free of rock outcrop and contain few, if any, large coarse fragments. All UMAs dominated by these soils have a negligible limitation (r_1). Some UMAs containing **Cheeseboro, Falkner, Russell, Niagara, Winvic, Yackadoo, Clarkei, clay surface variant** and **Dickson, shallow variant** as the dominant soil have a significant rockiness limitation ($r_{2\text{-}5}$). As well, every UMA with **Violet, Cherwell, Commissioner** and **Russell, stony phase** as the dominant soil has a significant rockiness limitation.

Microrelief (g). Microrelief refers to relief up to a few metres about the plane of the land surface (McDonald *et al.* 1984b). The microrelief limitation covers the effect microrelief has on causing uneven cultivation, impeding trafficability of machinery and reducing the effectiveness of fire to produce an ashbed and as an initial control of woody weeds. Features such as high soluble salts in mounds, coarse self-mulch and ponding in depressions can be associated with gilgai microrelief but

are covered in the salinity (sa), physical (p) and wetness (w) limitations.

Gilgai are the only form of microrelief that occur at Kilcummin. Normal, linear and lattice gilgai have a vertical interval of approximately 0.3 m or less and present only a negligible microrelief limitation (g_1) but melonhole gilgai, with a vertical interval greater than 0.3 m, can impede cultivation, the effectiveness of fire and even trafficability. The degree of limitation depends upon the amplitude of vertical interval and relative proportion of mounds, depressions and flat areas within a UMA. Cultivation is required infrequently for pastures and, in any UMA, the microrelief limitation is not as severe for a grazing enterprise as it is for cropping.

Kenmar, melonhole phase and **Midden, melonhole phase** have melonhole microrelief with vertical intervals between 0.3 m and 1.3 m. The UMAs dominated by these soils have a dense pattern of mounds and depressions with few flat areas and have been given a minor microrelief limitation (g_2). The vertical interval of **Nungaroo** is 0.15-0.6 m, mounds and depressions also form a dense pattern in UMAs dominated by this soil and they have been given a minor limitation as well. **Manar** soil generally has normal gilgai but two UMAs have melonhole gilgai and have been assigned a minor limitation as well. The remaining soils and UMAs have been assigned a negligible microrelief limitation (g_1).

Wetness (w). Wetness has been described in section 10.2.1. For beef cattle grazing, the wetness limitation takes into account the adverse effects of excess water on pasture production through reduced persistence of introduced species and through restrictions on the use of machinery following rain.

An excess of water occurs intermittently at Kilcummin in all clay soils, except probably the brightly coloured red and brown clays. This is only a short-term problem on most soils and any adverse effects are probably most common following heavy rainfall in winter when evaporation rates are low. More frequent and prolonged wetness occurs on soils of the low-lying level plains (**Maraconda** and **Nungaroo**) and in melonhole gilgai depressions of **Kenmar, melonhole phase** and **Midden, melonhole phase**. The UMAs dominated by these soils have been given a minor wetness limitation (w_2) while all other soils have been given a negligible limitation (w_1).

Water erosion (e). Beef cattle grazing generally increases the potential for soil loss during rainfall and subsequent run-of compared to land that has little effective disturbance. Clearing of vegetation can result in increased volume of run-off and increased velocity of water flow as well as a temporary decreased protection of the soil surface if mechanical methods are used. These effects are also produced by the increased grazing pressure which reduces ground cover while the occasional cultivation for seedbed preparation, pasture renovation and woody weed control results in temporary exposure of the soil surface. Erosion will result in declining productivity, and, eventually, an inability to maintain anything other than native pastures of low productivity.

The criteria used for determining the water erosion limitation are indicated in Table 28. The criteria are similar to those used for cropping (section 10.2.1) but, for any UMA, the equivalent limitation for cropping is greater as the effects of pastoral development on run-off, velocity of flow of water and protection of the surface soil are generally less.

The majority of UMAs on level plains have a negligible water erosion limitation (e_1). The UMAs on level plains with **Villafranca, Lebanon, Miscellaneous soils** or **Lebanon, red variant** and **Well, sandy surface variant** as the dominant soil have been assigned a limitation of some degree (e_2-e_4), as have the remaining UMAs on more undulating terrain.

Table 28. Criteria used for determining the water erosion limitation for beef cattle grazing

Limitation level	Landform attributes	Soil
1	level plains (slopes 0-1%)	all soils <u>except</u> Villafranca and Well, sandy surface variant
2	level plains (most slopes 0.5-1%)	Villafranca and Well, sandy surface variant;
	gently undulating plains (slopes 1-3%)	clays soils; Apron; Dickson, shallow variant; Violet; Windradene; Winvic; Yackadoo
	gently undulating rises (slopes 1-3%)	Commissioner; Violet; Winvic
3	gently undulating rises to undulating low hills (most slopes 2-7%)	clay soils; Apron; Dickson, shallow variant; Ok, gravel phase; Violet; Windradene
4	undulating rises to very steep hills and plateau remnants (most slopes >3%)	Clarkei; Clarkei, clay surface variant; Commissioner; Cherwell
	level to gently undulating plains and rises (most slopes >0.5%)	Heyford; Lebanon; Lebanon, red variant; Miscellaneous soils

Flooding (f). Land periodically inundated by water from stream channel overflow has a flooding limitation. The effects of flooding are described in section 10.2.1. In addition to these effects, repeated and prolonged flooding also reduces the persistence of many introduced pasture plants. Bambatsi panic is the only species that will persist under frequent to regular flooding.

There is greater potential for erosive damage under cropping than permanent pastures. On the other hand, the persistence of introduced species is very low in these conditions and sown pastures can be ruined with a flood. Therefore, the same flooding limitation has been assigned to UMAs for both cropping and beef cattle grazing:

- a minor limitation (f_2) for **Fletcher, Jeffray, Moramana, Solferino** and **Miscellaneous soils** along with some UMAs dominated by **Windradene, Moramana, gilgai phase** and **Midden, melonhole phase;**
- a moderate limitation (f_3) for UMAs with mainly **Cattle** soil; and
- a negligible limitation (f_1) for the remaining UMAs.

Vegetation (v). Timber clearing is essential to establish sown pastures in woodlands and open forests and is also used as a means of increasing dry matter production from native pastures under trees and shrubs. The long-term benefits of clearing for pasture improvement can be reduced by regrowth and invasion of woody weeds. After clearing eucalypt communities, woody weeds can often re-establish in greater densities than was present in the original community. The vegetation limitation refers to the long-term reduction in pasture productivity due to these effects.

The vegetation limitation has been assessed at Kilcummin on the basis of potential regrowth and the range of effective options available for control measures. The potential for woody weeds is minimal on self-mulching clay soils with downs and associated eucalypt open woodlands to woodlands, although the shrub gundabluie is invading some areas. The UMAs containing mainly these combinations of soil and vegetation are considered to have a negligible vegetation limitation (v_1). Regrowth can be a problem on the soils with brigalow, gidgee or boree scrub. False sandalwood, yellowwood, limebush and currant bush may become troublesome woody weeds as well as the dominant species. However, both chemical and mechanical methods can effectively control any regrowth on those soils without melonhole gilgai. The UMAs containing mainly scrub vegetation and without melonhole gilgai have been given a minor limitation (v_2).

Melonhole gilgai reduce the effectiveness of initial clearing because vegetation is not effectively removed from gilgai depressions. This increases the potential for regrowth as well as reducing the effectiveness of subsequent mechanical control. The UMAs having mainly scrub vegetation and melonhole gilgai have been assigned a moderate limitation (v_3). Regrowth of eucalypts can occur from either seedlings or lignotubers and is a potentially large problem if the soil is disturbed by mechanical methods. The UMAs with mainly eucalypt vegetation and firm to hard setting sandy loam to clay loam surface soils have also been assigned a moderate limitation. The only exceptions are those UMAs containing mainly **Villafranca** or **Jeffray** soil. Clearing the original vegetation on **Villafranca** by mechanical methods can result in prolific regrowth of both eucalypts and wattles. Flooding occurs occasionally on **Jeffray** and enhances seedling regrowth. The UMAs dominated by either **Villafranca** or **Jeffray** have been assigned a severe vegetation limitation (v_4).

10.3.2 Suitability results

The suitability class and the severity of all limitations are recorded on the UMA data file and are summarised for in Table 29 for each mapping unit.

Table 29. The land suitability limitations and classes for beef cattle grazing assigned to each mapping unit

Mapping unit	Limitations	Class
Apron	$m_{2-3}\ p_2\ e_{1-3}\ v_2$	2-3
Aroa	$m_{1-2}\ n_2\ p_3\ e_{1-2}$	3
Cattle	$f_3\ v_2$	3
Cheeseboro	$m_{4-5}\ n_2\ p_3\ r_{1-5}\ e_{1-3}$	4-5
Cherwell	$m_5\ n_4\ p_{2-3}\ r_{3-4}\ e_4$	5
Clarkei	$m_4\ n_3\ p_3\ e_4\ v_3$	5
Clarkei, clay surface variant	$m_2\ p_2\ r_{1-3}\ e_{3-4}\ v_2$	3-4
Commissioner	$m_5\ n_4\ p_3\ r_{4-5}\ e_{1-4}\ v_3$	5
Diamond	$n_2\ p_3\ e_{1-3}$	3
Diamond, footslope variant	$m_{1-2}\ n_3\ p_3\ e_{1-3}$	3
Dickson	$m_2\ p_2\ e_{1-2}\ v_{2-3}$	2-3
Dickson, shallow variant	$m_4\ p_2\ r_{1-4}\ e_{1-3}\ v_2$	4
Eleanor	$n_2\ p_3$	3
Eleanor, mottled phase	$n_3\ p_3$	3
Falkner	$m_{1-2}\ n_2\ p_3\ r_{1-2}\ e_{1-2}$	3
Fletcher	$m_2\ p_3\ f_2\ v_3$	4
Heyford	$m_4\ n_3\ p_3\ e_4\ v_3$	4
Holding	$n_2\ p_3\ e_2$	3
Jeffray	$p_3\ f_2\ v_4$	4
Kenlogan	$n_{1-2}\ p_{1-3}\ e_{1-2}\ v_{1-2}$	2-3
Kenmar	$e_{1-2}\ v_2$	2
Kenmar, melonhole phase	$m_2\ p_2\ g_2\ w_2\ v_3$	3
Lebanon	$m_3\ n_3\ p_3\ e_4\ v_3$	4
Lebanon, red variant	$m_3\ n_3\ p_3\ e_4\ v_3$	4
Manar	$g_{1-2}\ w_{1-2}\ v_2$	2
Maraconda	$m_3\ n_3\ p_4\ sa_2\ w_2$	4
Martyr	$p_{1-2}\ e_{1-2}\ v_{2-3}$	2
Midden	$p_{1-2}\ e_2\ v_2$	2
Midden, melonhole phase	$m_2\ p_2\ g_2\ w_2\ e_{1-2}\ f_{1-2}\ v_3$	3
Miscellaneous soils	$m_3\ n_3\ p_3\ e_4\ f_2\ v_3$	4
Moramana	$p_{2-3}\ e_{1-2}\ f_2\ v_{1-2}$	2-3
Moramana, gilgai phase	$p_3\ e_{1-2}\ f_{1-2}$	3
Niagara	$m_{1-2}\ r_{1-2}\ e_{1-2}\ v_2$	2
Nungaroo	$m_2\ n_2\ p_2\ g_2\ w_2\ v_3$	4
Ok	$m_2\ p_2\ e_{2-3}\ v_2$	2-3
Ok, gravel phase	$m_3\ p_2\ e_3\ v_2$	3
Rankin	$e_{1-2}\ v_2$	2
Russell	$m_{1-2}\ n_2\ p_3\ r_{1-2}\ e_{1-3}$	3
Russell, gilgai phase	$n_2\ p_3\ e_{1-2}$	3
Russell, stony phase	$n_2\ p_3\ r_3$	3

Table 29 (continued).

Mapping unit	Limitations	Class
Solferino	f_2 v_2	2
Vicenza	v_2	2
Villafranca	m_3 n_3 p_3 e_2 v_4	4
Violet	m_5 n_4 p_3 r_{2-5} e_{2-3} v_3	5
Well	e_{1-2} v_2	2
Well, footslope variant	m_2 n_2 p_3 sa_2 e_{1-2} v_2	3
Well, sandy surface variant	m_3 n_3 p_3 sa_2 e_2 v_2	4
Windradene	m_4 e_{1-3} f_{1-2} v_{1-2}	4
Winvic	m_4 n_3 p_2 e_{1-2} v_2	4
Yackadoo	m_4 n_2 p_2 r_{1-2} e_{1-2} v_2	4

No land is assigned to Class 1 (Table 30) but the majority of the area (65.5%) is considered suitable land for grazing sown pastures (Classes 2 and 3). A further 24.3% is assessed as either marginal land for grazing sown pastures or land on which native pastures can be oversown with shrubby stylos (Class 4). A small proportion (10.2%) is considered unsuitable land for extensive pasture development and is only suitable for grazing native pastures of low productivity.

Table 30. The proportion of land in each suitability class for beef cattle grazing

Land suitability class	Proportion of study area	
	Area (ha)	% of total area
1	nil	nil
2	64 940	22.8
3	121 770	42.7
4	69 370	24.3
5	29 150	10.2
Total	285 230	100.0

The area of land affected by each limitation is given in Table 31. In contrast with rainfed cropping, there is no single limitation operating at a significant level (minor to extreme) on all the land. Soil physical factors form the most widespread limitation affecting 217 620 ha or 76.3% of the area. Water erosion, nutrient deficiency, vegetation and water availability are also extensive limitations affecting 63.1%, 61.4%, 57.0% and 41.8% 0f the area respectively. Salinity, rockiness, microrelief, wetness and flooding limitations affect relatively small areas.

Table 31. The area (ha) and severity of each limitation for beef cattle grazing

Severity	Limitation									
	water availability (m)	nutrient deficiency (n)	soil physical factors (p)	salinity (sa)	rockiness (r)	microrelief (g)	wetness (w)	water erosion (e)	flooding (f)	vegetation (v)
negligible (1)	165 970	109 960	67 610	276 840	247 810	275 140	270 540	105 360	251 120	122 780
minor (2)	24 560	102 040	40 270	8 390	2 460	10 090	14 690	106 700	32 910	81 240
moderate (3)	41 980	47 610	172 750	nil	25 450	nil	nil	20 620	1 200	76 470
severe (4)	26 940	25 620	4 600	nil	5 650	nil	nil	52 550	nil	4 740
extreme (5)	25 780	nil	nil	nil	3 860	nil	nil	nil	nil	nil

10.4 Combined land suitability for agriculture

The land resources of the Kilcummin area are quite diverse. This has lead to considerable variation in suitability assessment for both rainfed cropping and beef cattle grazing. The type of land and its accompanying limitations differ markedly within individual classes as well as between classes. The assessment results from both classifications have been summarised in order to present information on the combined land suitability of every UMA.

The suitability data for rainfed cropping were arranged into two groups, reflecting their overall potential:

S suitable land (classes 2 and 3); and
U unsuitable land (classes 4 and 5).

Class 4 (marginal land) has been included with the unsuitable land as its long-term suitability is doubtful and conservative land use management would preclude this land from cropping until its potential can be more accurately determined.

The variation in land resources and limitations is reflected in the differing productivity of the native pastures and thus the relative advantage of any pasture improvement. It also produces important differences in the range of improved species suitable for introduction and methods available for their establishment. The suitability data for beef cattle grazing were arranged into six grazing enterprise options, identified as A to F. The distinguishing characteristics of each enterprise option are compared in Table 32.

The combined crop suitability potential and grazing enterprise option for each UMA are recorded on the UMA data file. The proportion of land in each combined group is given in Table 33. The distribution of the combined land suitability groups is shown on the accompanying land suitability map and the mapping units contained in each are given in Table 34.

Almost 19% of the area is suitable land for rainfed cropping and is also suitable for grazing a range of sown pastures which can be established by either sowing into an ashbed or with cultivation (SA). The land comprises deep clays with brigalow, gidgee or boree scrub as the original vegetation. The soil surface condition is either very fine self-mulching throughout or firm to hard setting on the mounds and very fine self-mulching in depressions. All the introduced grasses that are adapted to the area can be readily established on these lands although subsequent regrowth of woody weeds can form a minor to moderate hazard. Minor to moderate flooding occurs on some areas and may reduce the long-term persistence of most species except bambatsi and purple pigeon grass.

A further 35.5% of the area consists of land that is suitable for cropping but suitable only for grazing a limited number of sown grasses (SC). This includes most of the relatively deep clays with downs and associated eucalypt open woodlands to woodlands as the original vegetation. The vegetation is inadequate for producing an ashbed and only the larger seeded introduced grasses can be successfully established on the coarser self-mulching surfaces. However, the native grasses are highly productive in the virgin state and regrowth or invasion of woody weeds is negligible. Minor flooding occurs on some areas and may reduce the long-term persistence of most species except bambatsi and purple pigeon grass.

Table 32. Distinguishing characteristics of the six grazing enterprise options for Kilcummin

Enterprise option	Productivity of native pastures	Suitable grazing	Establishment of improved pastures	Woody weed regrowth
A	low under standing scrub, moderate after clearing	native pastures and a range of sown pastures	either into ashbed or with cultivation	minor to moderate hazard after clearing
B	low under standing scrub, moderate after clearing	native pastures and marginal to suitable land for a range of sown pastures	successful into ashbed, or difficult with cultivation	minor hazard after clearing
C	high	native pastures and a limited number of sown pastures	cultivation necessary	clearing unnecessary
D	low	native pastures oversown with shrubby stylos	onto surface or at very shallow depth	moderate to severe hazard after clearing
E	high	native pastures marginal for sown pastures	cultivation necessary for establishing sown pastures	clearing unnecessary
F	low	only native pastures	not applicable	clearing not recommended

Approximately 6% of the area constitutes land that is unsuitable for cropping but suitable for grazing a range of sown pastures which can be successfully established by either sowing into an ashbed or with cultivation (UA). The land comprises clay soils which have either a severe water availability or a topography limitation for cropping. The original scrub vegetation produces an adequate ashbed for pasture establishment. The surface condition of the dominant soils within UMAs included in this group is variable. There are soils with a very fine self-mulch on which sown pastures can be readily established in the absence of an ashbed. Those UMAs with mainly **Dickson** soil and scrub as the original vegetation are also in this group. **Dickson** has a firm to hard setting surface which may give a minor restriction to plant establishment if cultivated. Some soils with prominent gilgai are also included. The mounds have firm to hard setting or self-mulching surfaces giving a minor restriction to pasture establishment if cultivated. However, pasture establishment is generally successful on these soils. Minor flooding occurs on some areas and may reduce the persistence of most species except bambatsi and purple pigeon grass.

Table 33. The combined agricultural land suitability of Kilcummin

Crop suitability potential	Grazing enterprise option	Proportion of study area	
		Area (ha)	% of total area
S	A	53 810	18.8
S	C	101 160	35.5
U	A	15 880	5.6
U	B	20 740	7.3
U	C	6 550	2.3
U	D	36 200	12.7
U	E	21 420	7.5
U	F	29 470	10.3
TOTAL		285 230	100.0

Slightly more than 7% of the area comprises land that is unsuitable for cropping but is marginal to suitable land for grazing a range of sown pastures (UB). The land has either severe to extreme water availability, rockiness, water erosion or topography limitations or, a severe combination of several moderate limitations, for cropping. The original vegetation is scrub which can produce an adequate ashbed for establishment of sown pastures. **Apron, Ok** and **Ok, gravel phase** and **Clarkei, clay surface** variant have hard setting surface soils which make establishment difficult once the vegetation is removed. **Well, footslope variant** has a relatively coarse self-mulch that similarly makes establishment difficult with cultivation. Nevertheless, the UMAs containing mainly these soils are considered suitable for developing sown pastures as other limitations to production are not severe. **Windradene** and **Dickson, shallow variant** have a hard setting to very fine self-mulching surface on which plant establishment without an ashbed is more successful. However, other limitations reduce the long-term production and persistence of sown pastures on these two soils as well as on the hard setting **Winvic** and **Yackadoo** soils. The UMAs with mainly **Windradene, Winvic, Yackadoo** and **Dickson, shallow variant** are considered only marginal land for developing sown pastures.

A very small proportion of the area (around 2%) consists of land that is unsuitable for cropping but suitable for grazing a limited number of sown pastures (UC). This land consists of clay soils with downs and associated eucalypt communities as the original vegetation. They have either severe water availability, rockiness, water erosion or topography limitations or, a severe combination of several

minor to moderate limitations, for cropping. In addition, the original vegetation is inadequate for producing an ashbed and the coarser self-mulching clays limit the number of appropriate species for introduction. UMAs with mainly **Dickson** soil and eucalypt open woodlands are included. A wider range of sown pastures can be established on its firm to hard setting surface than on the self-mulching clays but these UMAs have been included in this group because there is no option available for sowing into an ashbed. However, the native pastures are highly productive in the virgin state and the invasion or regrowth of woody weeds is negligible. Minor flooding occurs on some areas and may reduce the persistence of most species except bambatsi and purple pigeon grass.

Approximately 13% of the area comprises land that is unsuitable for both cropping and sown pastures but suitable for grazing native pastures of low productivity oversown with shrubby stylos (UD). The land consists of hard setting duplex and gradational soils with eucalypt vegetation. This is unsuitable for cropping due to a combination of limitations and are also unsuitable for sown pastures due to a number of limitations. Woody weed regrowth forms a moderate to severe hazard and chemical treatment is the most appropriate method of clearing vegetation. However, the shrubby stylos can be successfully sown between standing timber and any disturbance to the vegetation is generally not necessary.

Table 34. The mapping units contained in each combined land suitability group

Combined land suitability group	Mapping units included
SA	Cattle (part); Kenlogan (part); Kenmar; Manar; Martyr (part); Midden; Niagara (part); Rankin; Solferino (part); Vicenza; Well
SC	Aroa (part); Diamond (part); Eleanor; Eleanor, mottled phase; Falkner (part); Holding; Kenlogan (part); Martyr (part); Moramana (part); Moramana, gilgai phase; Russell (part); Russell, gilgai phase
UA	Cattle (part); Dickson (part); Niagara (part); Nungaroo; Kenmar, melonhole phase; Midden, melonhole phase
UB	Apron; Clarkei, clay surface variant; Dickson, shallow variant; Ok; Ok, gravel phase; Well, footslope variant; Windradene (part); Winvic; Yackadoo
UC	Aroa (part); Diamond (part); Diamond, footslope variant; Dickson (part); Falkner (part); Moramana (part); Russell (part); Russell, stony phase
UD	Heyford; Lebanon; Lebanon, red variant; Miscellaneous soils; Villafranca
UE	Cheeseboro (part); Fletcher; Jeffray; Maraconda; Windradene (part)
UF	Clarkei; Cheeseboro (part); Cherwell; Commissioner; Violet; Well, sandy surface variant

A further 7.5% of the area constitutes land that is unsuitable for cropping, suitable land for grazing highly productive native pastures but only marginal land for grazing sown pastures (UE). The clay soils have downs and associated eucalypt open woodlands to woodlands as their original vegetation. The land has either a severe combination of several minor to moderate limitations or an extreme water availability limitation to cropping. An adequate ashbed cannot be produced for establishment of sown pastures and the hard setting or coarsely self-mulching surfaces restrict establishment if cultivation is necessary. Furthermore, the long-term production and persistence of any established pasture may be severely reduced by several limitations such as water availability, salinity, rockiness, flooding and regrowth of woody weeds. There are several UMAs containing mainly **Windradene** soil included in this group. The very fine self-mulching to firm surface does not significantly restrict establishment but long-term production and persistence are severely limited.

Approximately 10% of the area comprises unsuitable land for cropping and suitable only for grazing native pastures of low productivity (UF). This represents the very shallow and often stony lands with extreme limitations for both cropping and sown pastures. Included are very small areas dominated by the deeper **Well, sandy surface variant** which has numerous limitations prohibiting any agricultural development.

11. Guidelines for sound land use management

As a result of this study, the following guidelines are recommended for sound land use management:

- Only the land that is classified suitable for rainfed cropping should be used for this purpose. All the suitable land has a moisture availability limitation that reduces the maximum cropping success that can be attained to approximately 75%. That is, on average, at least one crop in four will fail.

- Almost half of this suitable cropping land is on a gently undulating topography and has a minor to moderate water erosion limitation. This assessment assumes that the current QDPI recommendations for vegetative cover and conservation management practices are adopted. The potential for soil loss by water erosion will be greater if these recommendations and practices are not followed.

- The land that is suitable for cropping is also suitable for grazing sown pastures. Approximately one-third has scrub as the original vegetation with native pastures of low productivity. This land (SA) can be successfully developed for either cropping or a range of sown pastures. The remaining land (SC) has highly productive native pastures in the virgin state and may be utilised in this condition or cropped. However, productivity often declines under constant grazing and a limited number of introduced grasses can be sown to delay or reverse this trend and to assist re-establishment of pastures in previously cropped areas.

- The land that is classified unsuitable for rainfed cropping should not be used for this purpose. A large proportion of this land has, among other limitations, a severe to extreme water erosion hazard and excessive land degradation can be expected if cropped. All this land is suitable for beef cattle grazing and this is the preferred use.

- Some of the unsuitable cropping land (12.6% of the area) is rated as Class 4 as it is doubtful whether crop yields will outweigh inputs in the long-term. Such land is also classified as either suitable to marginal land for grazing a range of sown pastures (UA, UB), or as suitable for grazing highly productive native pastures (UE). Those areas suitable for grazing a range of sown pastures could be developed for this purpose but land that is marginal for sown pasture development should be used for grazing native pastures only. Part of the land that is suitable for grazing highly productive native pastures (UMAs with mainly **Jeffray** soil) has a severe woody weed regrowth hazard and only chemical thinning of quite dense timber should be contemplated.

- Land that is suitable for grazing native pastures of low productivity oversown with shrubby stylos (UD) has a moderate to severe woody weed regrowth hazard. Most of this land has a severe water erosion hazard as well. However, the stylos can be successfully sown between the standing timber and any disturbance to the vegetation is not generally required. Only chemical thinning of the vegetation should be used if any disturbance is necessary. Applications of phosphorus as either fertiliser or supplements will be necessary to obtain maximum animal liveweight gains from the introduction of legumes.

- A substantial proportion of the land that is unsuitable for cropping is suitable for grazing low productivity native pastures only (UF). While not being suitable for extensive pasture improvement there is scope for limited improvement in favourable areas but clearing of the vegetation is not recommended.

- Vast reserves of lancewood associated with rosewood occur on the Cherwell Range and are suitable as fencing materials. Similarly, the remaining gidgee and brigalow scrub at Vicenza is a valuable source of fencing timber. These areas are worthy of reservation, either as Timber Reserves or as part of the national estate.

- The results of this study can be used as a basis for land use management and property development advice to landholders not only within the study area but also throughout the northern part of the Central Highlands.

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APPENDIX I

TERMINOLOGY USED TO DESCRIBE THE SOILS

The location, soil profile attributes, land surface, landform and vegetation structural formation were described according to McDonald *et al.* (1984a) except for the following:

. Surface flake was included as a description of the soil surface condition when dry. The definition of a surface flake has been taken from the second edition of the Australian soil and land survey field handbook which was not published during the period of field work (McDonald *et al.* 1990).

. The soil colours used to describe individual horizons of the representative profiles were those of the Revised Standard Soil Colour Charts (Oyama and Takehara 1970). Generalised soil colour names were used to describe the soil profile classes based on the following system:

Hue	Value/chroma rating group[a]				
	1	2a	2b	4	5a,5b
10R	dark	red-grey	red-brown	red	red
2.5YR	dark	grey-brown	red-brown	red	red
5YR	dark	grey-brown	brown	red-brown	red-brown
7.5YR	dark	grey-brown	brown	yellow-brown	brown
10YR	dark	grey	yellow-brown	yellow	brown
2.5Y	dark	grey	yellow-grey	yellow	olive-brown
5Y	dark	grey	yellow-grey	yellow	olive

[a] (Actual names of Oyama and Takehara (1970) were used for colours in the value/chroma rating group 3.)

The soil profile classes described in Appendix II represent a range of soil attributes compiled from many profile descriptions. These soils are also represented by individual profiles in Appendix III. The horizon notation (such as B_{21}) used for each representative profile in Appendix III indicates significant changes through that profile only, whereas the horizon notation used in Appendix II indicates significant trends across the range of soil profiles that constitute the soil profile class. Therefore, equivalent notation in the two appendixes do not necessarily describe the same features.

The parent material given for each soil profile class was taken from the relevant Bureau of Mineral Resources, Geology and Geophysics 1:250 000 Geological Series and Reports, and amended using local knowledge where necessary.

The Australian soil taxonomic units used were the Principal Profile Form of Northcote (1979), Great Soil Group of Stace *et al.* (1968).

The Soil Taxonomy (Soil Survey Staff 1975) and FAO-Unesco units (FAO 1974) were also given for the representative profiles but the Soil Taxonomy equivalents are approximate only. Extrapolation was necessary in determining Soil Taxonomy units due to the lack of data and use of analytic methods that differ from those specified. The presence of an argillic horizon was decided solely on the basis of particle size specifications.

APPENDIX II

DESCRIPTION OF THE SOIL PROFILE CLASSES

AND MISCELLANEOUS SOILS

APRON

Major attributes: A gravelly, hard setting, red to grey-brown, clay, clay loam, gradational soil or duplex soil with neutral to alkaline reaction trend overlying quartz gravel and buried layers by 1100 mm depth

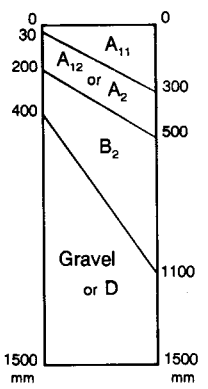
Principal profile forms: Uf6.31, Gn3.12, Um3, Db1.42, Um5.51 **Great soil group:** No suitable group

Parent material: Cainozoic sediments (gravel and soil material)

Landform: Gently undulating rises and plains

Predominant vegetation: Brigalow, tall to mid-high, open forest to open woodland

Surface features: Very few to many, quartz, volcanic and sedimentary, fine gravel to cobble; hard setting



A_{11}: Grey-brown to red and dark (7.5YR to 2.5YR 3/3, 4/2 to 4/4 and 2/1), grey to red-brown (dry); sandy clay loam to sandy clay; massive to weak subangular blocky; dry moderately weak to moderately firm; may have many fine to coarse gravel; pH 5.8-8.5. Abrupt to gradual to -

A_{12} or A_2 (where present): Red-brown to light grey (5YR to 10YR 4/4 to 7/1); sandy clay loam; may be sporadically or conspicuously bleached; few to many fine to coarse gravel; pH 6.0-6.5. Abrupt to gradual to -

B_2 (where present): Red to grey-brown (2.5YR to 7.5YR 3/3 to 5/6); clay loam, sandy to medium heavy clay; weak to strong structure; may have very abundant fine to coarse gravel; may have common carbonate nodules; pH 6.5-8.5.

AROA

Major attributes: A lattice and linear gilgai complex overlying limestone and calcareous marl below 600 mm depth
Mounds: self-mulching, red-brown to grey-brown, mainly cracking clay with alkaline reaction trend
Depressions: self-mulching, grey-brown to dark, cracking clay with alkaline reaction trend

Principal profile forms: *(mounds):* Ug5.37, Ug5.25, Ug5.32, Uf6.31, Uf6.33, Ug5.24 **Great soil group:** *(mounds):* Red and brown clay and no suitable group

(depressions): Ug5.22, Ug5.21, Ug5.12, Ug5.11, Ug5.25, Ug5.13 *(depressions):* Grey clay and black earth

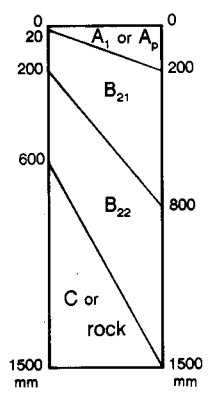
Parent material: Cainozoic soft and hard limestone and calcareous marl

Landform: Gently undulating to level plains

Predominant vegetation: Mountain coolibah, tall, or gum topped bloodwood, tall to mid-high, open woodland to woodland

Surface features: Linear and lattice gilgai (vertical interval .05-.20 m, horizontal interval 5-20 m); may have many basalt, quartz, limestone and ironstained fine to coarse gravel; self-mulching and mainly cracking on mounds, cracking and self-mulching in depressions

Mounds

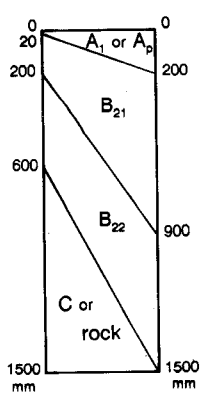


A_1 or A_p: Red-brown to grey-brown and dark (5YR to 7.5YR 5/4 to 3/3 and 3/2); red-brown to dark (dry); light medium to medium heavy clay; moderate to strong 2-10 mm subangular blocky parting to strong <2 mm granular; dry loose; very few to very many carbonate nodules; pH 8.0-9.0. Abrupt to gradual to -

B_{21}: Red-brown to grey-brown (5YR to 7.5YR 4/2 to 4/4 and 5/6); medium to medium heavy clay; moderate to strong structure; dry very firm to very strong; may have few fine to medium subangular gravel; may have many carbonate nodules and soft segregations; pH 8.5-9.0. Clear to diffuse to -

B_{22}: Red-brown to brown (5YR to 7.5YR 3/4 to 5/6); medium to heavy clay; strong lenticular; dry very firm to moderately strong; may have few fine to medium subangular gravel; few to many carbonate nodules and soft segregations and may have few manganiferous veins and nodules; pH 8.5-9.0.

Depressions



A_1 or A_p: Dark to grey-brown (5YR to 10YR 3/1 to 4/2), dark to grey-brown (dry); light medium to medium heavy clay; moderate to strong 2-10 mm subangular blocky occasionally parting to <2 mm granular; dry loose; may have few fine to medium subangular gravel; may have common carbonate nodules; pH 7.5-9.0. Abrupt to gradual to -

B_{21}: Dark to grey-brown (5YR to 10YR 2/1 to 4/2); medium to heavy clay; dry very firm to moderately strong; may have common fine to medium gravel; may have common carbonate nodules; pH 8.0-9.0. Abrupt to gradual to -

B_{22}: Dark to red-brown (5YR to 10YR 3/1 to 5/4); medium to heavy clay; strong lenticular; dry very firm to moderately strong; may have common fine to medium gravel; very few to common carbonate nodules and soft segregations, may have few gypsum crystals and few manganiferous nodules and veins; 8.0-9.0.

Note: A few mound profiles may have a firm surface which forms only a weak self-mulch upon disturbance (Uf6.31).

CATTLE

Major attributes: A very fine self-mulching, grey to dark, cracking clay with acid reaction trend overlying buried sand layers and/or strongly and coarsely mottled, acid, gleyed clay

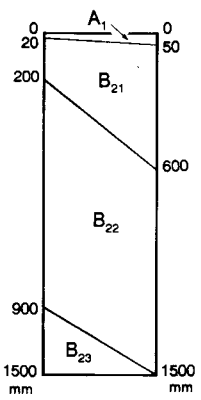
Principal profile forms: Ug5.2, Ug5.15, Ug5.24, Ug5.25, Ug5.29 **Great soil group:** Grey clay and black earth

Parent material: Quaternary alluvium

Landform: Alluvial plains (may be frequently flooded)

Predominant vegetation: Gidgee and brigalow, tall to mid-high, open forest to woodland

Surface features: May have incipient normal gilgai (vertical interval .05-.10 m, horizontal interval 2-10 m); may have few, fine, quartz and ironstained gravel; cracking and self-mulching



A_1: Dark to brown (10YR to 7.5YR 3/2 to 4/3), dark to brown (dry); medium to medium heavy clay; moderate to strong 2-10 mm subangular blocky parting to strong <2 mm subangular blocky and granular; dry loose; may have common carbonate nodules; pH 7.0-9.0. Abrupt to clear to -

B_{21}: Grey to dark and occasional grey-brown (10YR to 2.5Y 4/2, 3/2 and occasional 7.5YR to 5YR 4/2); medium heavy to heavy clay; blocky structure; dry very firm to moderately strong; may have few carbonate nodules and few gypsum crystals; pH 8.0-9.0. Abrupt to diffuse to -

B_{22}: Grey-brown to dark and occasional brown to red-brown (2.5Y to 7.5YR 3/2 to 5/3 and occasional 5YR to 7.5YR 3/3, 4/3); medium heavy to heavy clay; strong lenticular; dry very firm to moderately strong; very few to common gypsum crystals and may have many manganiferous veins and few carbonate nodules and soft segregations; pH 5.0-9.0. Clear to gradual to -

B_{23}: As for B_{22}, except may have common fine to coarse gley, red and orange mottles; pH 4.5-7.0.

Notes: 1. Buried layers of sand or strongly and coarsely mottled, acid gleyed clay may be present below 1500 mm depth.

2. The alkaline pH does not extend below 1200 mm depth.

CHEESEBORO

Major attributes: A stony, self-mulching to hard setting, dark to red-brown clay with neutral to alkaline reaction trend overlying basalt by 400 mm depth

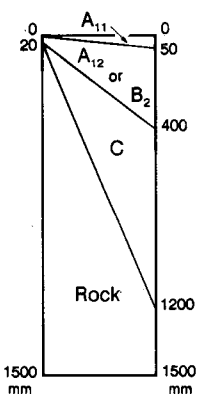
Principal profile forms: Uf6.32, Uf6.33, Ug5.12, Uf6.31 **Great soil group:** No suitable group and black earth

Parent material: Tertiary basalt

Landform: Rolling low hills to level plains

Vegetation: Mountain coolibah, tall, or gum topped bloodwood, tall to mid-high, open woodland to woodland or Queensland bluegrass, tall, tussock to open tussock grassland

Surface features: May have >50% bedrock exposed; may have abundant fine basalt gravel and stone; self-mulching to hard setting (and occasionally cracking)



A_{11} (where present): Dark to red-brown (5YR to 10YR 2/1 to 4/4), dark to red-brown (dry); light to medium clay; moderate to strong 5-10 mm subangular blocky parting to <2 mm granular; dry loose to moderately weak; may have common carbonate nodules; pH 6.5-8.5. Clear to -

A_{12} or B_2: Dark to red-brown (5YR to 10YR 2/1 to 4/4); light to medium clay; moderate to strong 2-10 mm subangular blocky becoming lenticular with depth; dry moderately weak to moderately firm; may have abundant basalt fragments; may have common coarse carbonate nodules; pH 7.0-8.5. Clear to gradual to -

C (where present): Weathered basalt; may have many carbonate segregations.

CHERWELL

Major attributes: A very rocky and gravelly, red-brown to dark, sand to sandy clay loam with acid to neutral reaction trend overlying sandstone by 600 mm depth

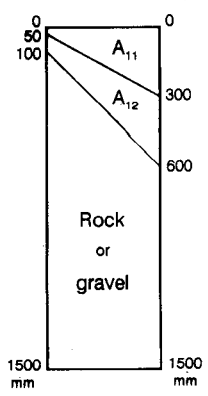
Principal profile forms: Uc1.23, Uc1.21, Um1.23, Uc1.24 **Great soil group:** Lithosol

Parent material: Permian quartzose sandstone

Landform: Rolling low hills to undulating rises

Predominant vegetation: Lancewood, mid-high to tall, open to closed forest

Surface features: May have 50% rock outcrop and few to abundant, fine quartz gravel and sandstone cobble; soft to hard setting



A_{11}: Red-brown to dark (5YR to 10YR 4/4 to 2/2), brown to light grey (dry); loamy coarse sand to sandy clay loam; massive; dry very weak to moderately weak; may have abundant fine to medium, quartz and sandstone gravel; pH 5.0-7.0. Clear to gradual to -

A_{12} (where present): Brown to red-brown (5YR to 7.5YR 3/3 to 5/4); coarse sand to sandy clay loam; apedal; dry loose to moderately weak; may have abundant fine to coarse quartz and sandstone gravel; pH 5.0-6.5.

Note: Occasionally, a conspicuously bleached A_2 may occur, instead of the A_{12}, over a thin C horizon overlying rock (Uc2.12).

CLARKEI

Major attributes: A gravelly, hard setting, red-brown to brown, sandy loam to clay loam, sandy surface soil either overlying an alkaline red-brown to brown (sandy) clay subsoil or directly overlying sandstone

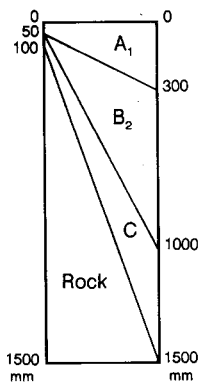
Principal profile forms: Dr2.12, Um1.13, Dr2.13, Dy2.13, Dy2.12, Uc1.13 **Great soil group:** No suitable group

Parent material: Permian sandstone, siltstone and coquinite containing abundant marine bivalve shells (in particular, *Strophalosia clarkei*)

Landform: Rolling low hills

Predominant vegetation: Mountain coolibah, tall, open woodland to woodland

Surface features: May have 10% rock outcrop; common to abundant, fine gravel to cobble; hard setting



A_1: Red-brown to brown (5YR, 7.5YR 4/3, 5/3), brown to yellow-brown (dry); loamy sand to clay loam, sandy; may have abundant medium to coarse gravel; pH 7.0-8.5. Abrupt to gradual to -

B_2 (where present): Brown to red (7.5YR to 2.5YR 4/4 to 5/6); sandy clay to sandy medium clay; strongly structured; may have few medium gravel; may have few to common carbonate soft segregations and nodules; pH 8.0-8.5. Clear to gradual to -

C: Many to very abundant coarse fragments; may have common to very many carbonate soft segregations.

CLARKEI, CLAY SURFACE VARIANT

Major attributes: A stony, hard setting, brown to red-brown clay with alkaline reaction trend overlying sedimentary rocks by 450 mm depth

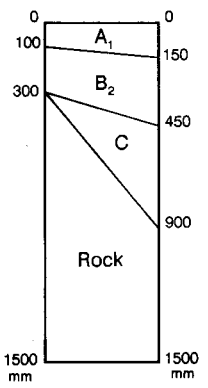
Principal profile forms: Uf6.31 **Great soil group:** No suitable group

Parent material: Permian sedimentary rocks, including fine grained sandstone

Landform: Level to gently undulating plateau remnants

Predominant vegetation: Brigalow, tall to mid-high, open forest

Surface features: Very few to abundant, sandstone cobble and stone; hard setting



A_1: Dark to brown (7.5YR, 10YR 3/2 to 4/3), dark to grey (dry); light medium to medium heavy clay; weak to moderate 5-10 mm subangular blocky; dry moderately firm to moderately strong; may have common sandstone cobble; pH 6.5-9.0. Clear to gradual to -

B_2: Brown to red-brown (5YR to 10YR 4/4 to 4/8); light medium to medium heavy clay; moderate to weak structure; dry moderately strong; few to many fine sandstone gravel; may have very few carbonate soft segregations; pH 7.5-9.0. Gradual to -

C (where present): Bluish-grey to olive-brown; medium clay; may have abundant fine sandstone gravel; pH 8.5-9.0.

COMMISSIONER

Major attributes: A very rocky and stony, hard setting, dark, loamy sand to sandy clay loam with acid reaction trend overlying acid to intermediate volcanic rocks by 300 mm depth

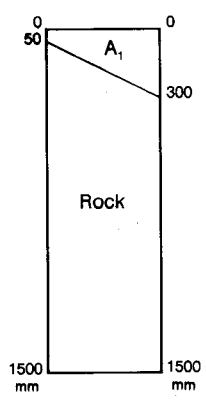
Principal profile forms: Um1.44, Uc1.44, Uc1.24 **Great soil group:** Lithosol

Parent material: Tertiary rhyolite and alkaline trachyte (with minor Devonian/Carboniferous andesitic flows and pyroclastics)

Landform: Very steep hills to gently undulating rises

Predominant vegetation: Narrow leaved ironbark, tall to mid-high, open woodland to woodland or mountain coolibah, tall, open woodland to woodland

Surface features: May have 50% rock outcrop; many to very abundant rhyolite and trachyte stone; hard setting



A_1: Dark (7.5YR 2/2, 3/1, 3/2), grey to grey-brown (dry); loamy sand to sandy clay loam; massive; dry moderately weak; many to very abundant fine gravel to stone; pH 5.5-7.0.

Note: On mid to lower slopes of gently undulating rises small areas of sandy duplex soils (Dd2.43, Dy3.33) may occur. These soils overlie rock below 1000 mm depth.

DIAMOND

Major attributes: A self-mulching, red-brown to brown, cracking clay with alkaline reaction trend overlying brightly coloured clay interbedded with layers of weathered basalt

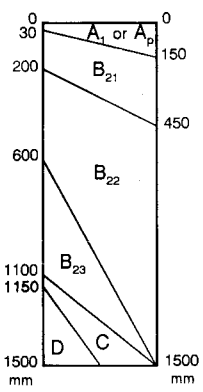
Principal profile forms: Ug5.38, Ug5.34, Ug5.39, Ug5.3 **Great soil group:** Red and brown clay

Parent material: Cainozoic unconsolidated sediments

Landform: Gently undulating rises to level plains

Predominant vegetation: Queensland bluegrass, tall, tussock to open tussock grassland

Surface features: May have incipient linear and lattice gilgai (vertical interval .05-.15 m, horizontal interval 10-15 m); cracking and self-mulching



A_1 or A_p: Red-brown to brown (5YR to 7.5YR 4/3 to 5/4), red-brown to grey-brown (dry); medium to medium-heavy clay; moderate to strong 2-10 mm subangular blocky occasionally parting to <2 mm granular; dry loose; may have many carbonate nodules; pH 7.5-9.0. Clear to gradual to -

B_{21}: Red-brown to brown (5YR to 7.5YR 3/4, 4/4 and 4/3); medium to heavy clay; moderate to strong blocky; dry moderately firm to moderately strong; may have many carbonate nodules; pH 8.5-9.0. Abrupt to diffuse to -

B_{22}: Red-brown to brown (5YR to 7.5YR 3/4 to 5/6); medium to heavy clay; strong lenticular; dry very firm to moderately strong; very few to many carbonate nodules and soft segregations; pH 8.5-9.0. Abrupt to diffuse to -

B_{23} (where present): As for B_{22}, except may have common fine to medium grey, yellow and brown to red mottles; very few to many gypsum crystals and/or few to many manganiferous veins and/or very few to many carbonate nodules and soft segregations; pH 8.0-9.0. Clear to diffuse to -

C: Brightly coloured clay and fine sandy to sandy weathered basalt. Overlying -

D (where present): Strongly and coarsely mottled, gley, red and yellow acid clay

Notes: 1. Rarely, the B_{21} and B_{22} horizons may be grey-brown (5YR 4/2) resulting in intergrades (Ug5.2) to grey clays.

2. The D horizon tends to have neutral pH (6.0-8.3) in the uppermost part.

DIAMOND, FOOTSLOPE VARIANT

Major attributes: A coarse self-mulching, red-brown to grey-brown, cracking clay with acid to alkaline reaction trend overlying strongly and coarsely mottled, acid, gleyed clay below 400 mm depth

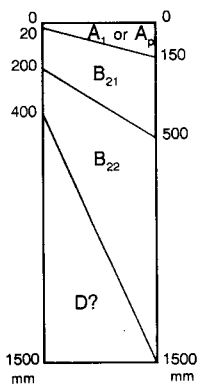
Principal profile forms: Ug5.39, Ug5.38, Ug5.35, Ug5.34, Ug5.2 **Great soil group:** Grey, brown and red clay

Parent material: Cainozoic unconsolidated sediments

Landform: Undulating to gently undulating rises

Predominant vegetation: Queensland bluegrass-mitchell grasses, tall, tussock to open tussock grassland

Surface features: Cracking and self-mulching



A_1 or A_p: Grey-brown to red-brown (7.5YR to 5YR 4/2 to 4/4), grey to red-brown (dry); medium to heavy clay; moderate to strong 2-20 mm subangular blocky occasionally parting to <2 mm subangular blocky and granular; dry loose; may have few carbonate nodules; pH 7.0-9.0. Abrupt to gradual to -

B_{21}: Red-brown to grey-brown (7.5YR to 5YR 4/2 to 4/4 and 5/3); medium to heavy clay; moderate 10-50 mm angular blocky; may have few carbonate nodules; pH 7.0-9.0. Clear to diffuse to -

B_{22}: As for B_{21}, except may have few medium distinct gley and brown to red mottles; strong lenticular structure; may have few carbonate nodules and/or common gypsum crystals and/or common manganiferous veins; pH 6.0-8.7. Clear to diffuse to -

D?: Strongly and coarsely mottled, gley, red and yellow acid clay.

Note: The D? horizon may have neutral pH (up to 8.0) in the uppermost part.

DICKSON

Major attributes: A firm to hard setting, red clay with neutral to alkaline reaction trend overlying basalt below 600 mm depth

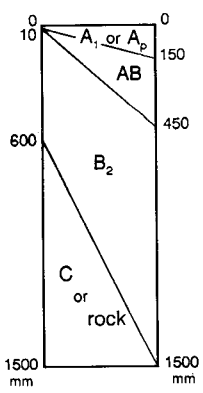
Principal profile forms: Uf6.31 **Great soil group:** No suitable group

Parent material: Tertiary ferruginised basalt

Landform: Level to gently undulating plains

Predominant vegetation: Reid River box, tall to mid-high, open woodland to woodland or gidgee and brigalow, tall to mid-high, open forest to woodland

Surface features: May have common, coarse, ferruginised and basalt gravel; firm to hard setting (and occasionally self-mulching)



A_1 or A_p: Red to red-brown (2.5YR to 5YR 3/3 to 4/6), red to red-brown (dry); light to medium clay; massive to strong 2-5 mm blocky; dry moderately weak to moderately firm; may have very few carbonate nodules; pH 6.0-7.5. Abrupt to gradual to -

AB (where present): Red to red-brown (5YR to 10R 3/3 to 4/6); light to medium clay; weak to moderate structure; dry moderately weak to very firm; may have many fine to coarse gravel; pH 6.0-8.0. Abrupt to gradual to -

B_2: Red (10R to 2.5YR 3/3 to 5/6); light to medium clay; weak to strong structure; dry moderately firm to very strong; may have many fine to coarse gravel; may have common carbonate nodules and soft segregations and few manganiferous nodules; pH 6.0-8.7

C (where present): Weathered basalt

Note: The self-mulching surface is common where the soil merges with either **Niagara** or **Russell** soils.

DICKSON, SHALLOW VARIANT

Major attributes: A gravelly, hard setting to very fine self-mulching, red clay with acid to alkaline reaction trend overlying ferruginised gravel or red tuff by 400 mm depth

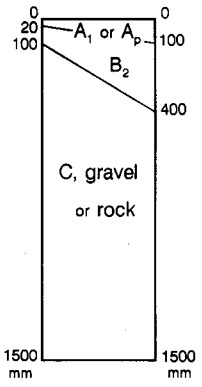
Principal profile forms: Uf6.31, Uf6.53 **Great soil group:** No suitable group

Parent material: Probably, ferruginised (basalt and acid) volcanic rocks and red lithic, crystal tuff

Landform: Gently undulating plains and rises

Predominant vegetation: Brigalow and gidgee, tall to mid-high, open forest to woodland

Surface features: Very few to many, fine to coarse, ferruginised gravel; hard setting to self-mulching



A_1 or A_p: Red (2.5YR 3/4 to 4/6), red (dry); light to light medium clay; weak to strong <2-5 mm subangular blocky; dry loose to moderately weak; pH 6.0-8.5. Abrupt to clear to -

B_2: Red (2.5YR 3/4 to 5/6); light to medium clay; weak to moderate structure; dry moderately firm to moderately strong; may have common fine to medium ferruginised gravel; pH 6.0-8.5

ELEANOR

Major attributes: An occasionally normal, linear or lattice gilgai, self-mulching, grey-brown to grey, cracking clay with neutral to alkaline reaction trend overlying buried clay, sand and unconsolidated gravel

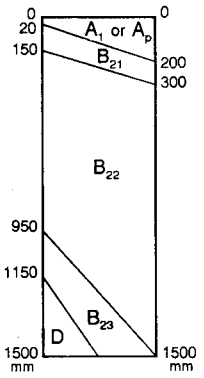
Principal profile forms: Ug5.24, Ug5.25, Ug5.29 **Great soil group:** Grey clay

Parent material: Cainozoic unconsolidated sediments

Landform: Level plains

Predominant vegetation: Queensland bluegrass, tall, tussock to open tussock grassland or coolibah or inland bloodwood, tall to mid-high, open woodland

Surface features: May have normal, linear or lattice gilgai (vertical interval .05-.20 m, horizontal interval 5-15 m); may have many fine to medium, quartz and ironstained gravel; cracking and self-mulching



A_1 or A_p: Grey to grey-brown (7.5YR to 2.5Y 4/1, 4/2), grey to grey-brown (dry); medium to heavy clay; moderate to strong 2-10 mm subangular blocky occasionally parting to <2 mm subangular blocky and granular; dry loose; may have few fine to medium quartz and ironstained gravel; very few to many carbonate nodules; pH 8.0-8.7. Clear to gradual to -

B_{21}: Grey-brown to grey (7.5YR to 2.5Y 4/1, 4/2); medium heavy to heavy clay; moderate to strong 10-50 mm blocky; dry very firm to moderately strong; may have common fine to medium quartz gravel; very few to many carbonate nodules; pH 8.0-9.0. Clear to diffuse to -

B_{22}: As for B_{21}, except for strong lenticular structure and may have few medium brown and red mottles at depth. Clear to diffuse to -

B_{23}: Red-brown to grey-brown and rarely grey (7.5YR to 5YR 4/2 to 5/6 and 10YR 5/2); medium to heavy clay; may have 50% red, brown and grey mottles; dry very firm; may have common fine to medium quartz gravel; may have very many carbonate nodules and soft segregations and/or common gypsum crystals and/or many manganiferous veins; pH 6.0-8.5. Clear to diffuse to -

D: A mixture of red clay, fine sand and loose gravel

Notes:

1. Occasionally the B_{22} horizon may directly overlie the D horizon.
2. Rarely, the profile is dark to the bottom of the B_{22} horizon (Ug5.16, Ug5.15).
3. The fine sand and much of the loose gravel in the D horizon are of basaltic origin.

ELEANOR, MOTTLED PHASE

Major attributes: Similar to Eleanor except for the following:

- 'a more frequent occurrence of dark colours in the surface soil and upper part of the subsoil;
- the presence of a strongly and coarsely mottled, acid, gleyed clay (which may be alkaline in the upper part) below 1200 mm depth

FALKNER

Major attributes: A coarse self-mulching, grey-brown to dark, cracking clay with alkaline to neutral reaction trend overlying basalt below 500 mm depth

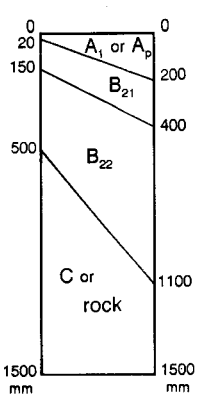
Principal profile forms: Ug5.22, 5.12 **Great soil group:** Grey clay to black earth

Parent material: Tertiary basalt

Landform: Gently undulating to level plains

Predominant vegetation: Queensland bluegrass, tall, tussock to open tussock grassland

Surface features: May have few basalt cobble; cracking and self-mulching



A_1 or A_p: Grey-brown to dark (7.5YR to 10YR 4/2, 4/1 and 3/1), grey-brown to dark (dry); medium heavy to heavy clay; strong 2-10 mm subangular blocky and granular; dry loose; may have few carbonate nodules; pH 7.0-8.7. Abrupt to gradual to -

B_{21}: Grey-brown to dark (7.5YR to 10YR 4/2, 4/1 and 3/1, 3/2); medium to heavy clay; dry moderately strong to very strong; may have very few fine to medium gravel; may have very few carbonate nodules; pH 7.5-8.5. Clear to gradual to -

B_{22}: As for B_{21} except has strong lenticular structure and pH 8.0-8.5

C (where present): Weathered basalt

FLETCHER

Major attributes: A firm to hard setting, red to grey-brown, non-cracking clay with neutral to alkaline reaction trend overlying unconsolidated sediments

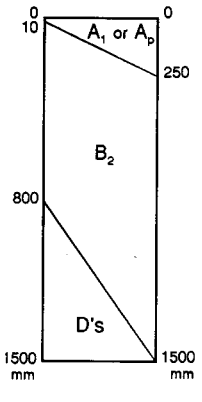
Principal profile forms: Uf6.31, Uf6.33 **Great soil group:** No suitable group

Parent material: Quaternary alluvium

Landform: Alluvial plains (may be frequently flooded)

Predominant vegetation: Poplar box or coolibah, tall, open woodland to woodland

Surface features: May have abundant, fine to coarse, quartz, basalt and other gravel; firm to hard setting



A_1 or A_p: Grey-brown to red and occasional dark (7.5YR to 2.5YR 4/2, 4/3, 3/3, 3/4 and occasional 3/2), grey-brown to red (dry); sandy clay to sandy, medium heavy clay; massive to moderate 2-5 mm subangular blocky; dry moderately weak to moderately strong; may have common fine to medium quartz, basalt and other gravel; pH 6.0-8.5. Abrupt to gradual to -

B_2: Red to grey-brown (2.5YR to 10YR 5/6 to 3/3, and 4/2); medium to heavy clay; may have 50% grey and yellow mottles at depth; dry very firm to moderately strong; may have many fine to medium quartz, basalt and other gravel; may have common carbonate nodules and soft segregations and common manganiferous nodules and soft segregations and common gypsum crystals; pH 6.0-8.7. Clear to gradual to -

D's: Gravel, gravelly clay and sand or strongly and coarsely mottled, acid, gleyed clay

Note: Structure in the B_2 horizon of some profiles may be only weakly pedal (Uf6.53).

HEYFORD

Major attributes: A duplex soil with sandstone gravel and hard setting, dark to red-brown, loamy sand to sandy clay loam surface and bleached subsurface over an alkaline, mottled grey, yellow and red-brown clay subsoil overlying sandstone

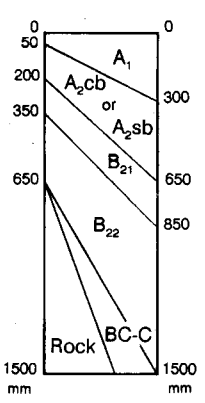
Principal profile forms: Dy3.43, Dy3.33 **Great soil group:** Solodized solonetz and solodic soil

Parent material: Permian (and minor Devonian-Carboniferous) sedimentary rocks

Landform: Gently undulating plains and rises

Predominant vegetation: Poplar box, tall, open woodland to woodland

Surface features: May have common, fine to medium gravel; hard setting



A_1: Dark to red-brown (5YR to 10YR 3/2 to 4/4), grey-brown to brown (dry); loamy sand to sandy clay loam, massive; dry very weak to moderately weak; may have common fine to medium quartz and sandstone gravel; pH 6.0-7.5. Abrupt to gradual to -

A_2cb or A_2sb: Red-brown to grey (5YR to 10YR 4/3 to 6/4); loamy sand to light sandy clay loam; massive; dry very weak to moderately weak; may have very abundant coarse quartz and sandstone gravel; pH 5.5-7.5. Abrupt to clear to -

B_{21}: Mottled grey, yellow and red-brown (10YR to 5YR 4/1 to 6/2 and 5/4 to 6/8); sandy, medium clay to medium heavy clay; medium to strong >100 mm columnar, prismatic or angular blocky; dry very firm to very strong; may have common fine to coarse gravel; may have few soft manganiferous segregations; pH 6.0-8.0. Clear to gradual to -

B_{22}: As for B_{21}, except may have common carbonate soft segregations and nodules; pH 8.5-9.0. Clear to gradual to -

BC-C (where present): Grey to yellow-brown (7.5YR to 10YR 5/2 to 6/6); sandy, light medium to medium clay; may have common grey and yellow mottles; may have very abundant sandstone gravel; may have common carbonate soft segregations and nodules; pH 8.5-9.0

Notes: 1. Occasionally, the B_{21} is strongly alkaline; a bleach may occur in the A_1; rarely, an acid profile (Dy3.41) may be encountered.

2. Occasionally, red-brown profiles without a bleached A_2 (Db1.23, Dr2.12) are encountered.

HOLDING

Major attributes: A linear, lattice and normal gilgai complex overlying cemented gravel and sandy clay
Mounds: firm to self-mulching, red-brown to grey-brown clay with alkaline reaction trend
Depressions: self-mulching, grey-brown to dark, cracking clay with alkaline reaction trend

Principal profile forms: *(mounds):* Uf6.31, Ug5.38, Ug5.34, Ug5.3, Ug5.2, Uf6.33 **Great soil group:** *(mounds):* No suitable group and red, brown and grey clay

(depressions): Ug5.2, Ug5.24, Ug5.28, Ug5.3, Ug5.17 *(depressions):* Grey and brown clay and black earth

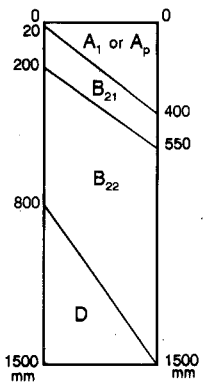
Parent material: Cainozoic unconsolidated sediments

Landform: Gently undulating plains and rises

Predominant vegetation: Inland bloodwood, tall to mid-high, open woodland to woodland

Surface features: Linear, lattice and normal gilgai (vertical interval .05-.35 m, horizontal interval 5-20 m); may have many, fine to coarse, quartz and ironstained gravel on mounds, may have few, fine to medium, quartz and ironstained gravel in depressions; firm to self-mulching (and occasionally cracking) on mounds, cracking and self-mulching in depressions

Mounds



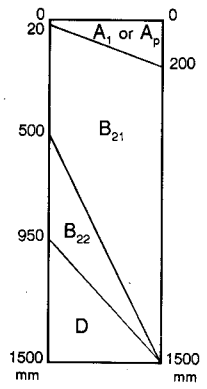
A_1 or A_p: Red-brown to grey-brown (5YR to 7.5YR 4/2-4/4 and 5/3), red-brown to grey-brown (dry); light to medium heavy clay; weak to strong 2-10 mm subangular blocky occasionally parting to <2 mm subangular blocky and granular; dry loose to moderately firm; may have few fine to medium gravel; few to very many carbonate nodules; pH 8.0-8.7. Abrupt to clear to -

B_{21}: Red-brown to grey-brown and occasional grey (5YR to 10YR 4/6-4/2 and 5/4); light to medium heavy clay; dry moderately firm to moderately strong; may have common fine to coarse gravel; very few to many carbonate nodules; pH 8.5-9.0. Abrupt to gradual to -

B_{22}: As for B_{21}, except may have few medium distinct mottles at depth; light medium to medium heavy clay; may have very many carbonate nodules and soft segregations and common manganiferous veins at depth. Abrupt to diffuse to -

D: Cemented gravel and/or sandy clay

Depressions



A_1 or A_p: Grey-brown to dark and occasional red-brown (2.5YR to 7.5YR 4/2 to 3/1 and occasional 4/3); grey-brown to dark (dry); medium to heavy clay; moderate to strong 2-10 mm subangular blocky occasionally parting to <2 mm subangular blocky and granular; dry loose; may have many carbonate nodules; pH 7.7-8.7. Clear to gradual to -

B_{21}: Grey-brown to dark and occasional red-brown (2.5Y to 7.5YR 4/2 to 3/1 and occasional 4/3); medium to heavy clay; dry very firm to moderately strong; may have few fine to coarse gravel; very few to common carbonate nodules; pH 8.5-9.0. Clear to diffuse to -

B_{22} (where present): Brown to red-brown (5YR to 7.5YR 4/3 to 5/4); may have many grey mottles; medium to heavy clay; dry very firm to moderately strong; may have few fine to coarse gravel; may have many carbonate nodules and soft segregations and few gypsum crystals; pH 8.5-8.7. Clear to diffuse to -

D: Cemented gravel and/or sandy clay

Notes: 1. The structure of the B_2 horizons usually becomes strong lenticular with depth below both mounds and depressions.

2. The D horizon contains sandy clay (with or without fine to coarse gravel) and/or a layer of cemented, fine to coarse gravel. The loose and cemented gravel consist of quartz, basalt, sandstone and other ironstained gravel.

JEFFRAY

Major attributes: A self-mulching, grey to dark, cracking clay with acid to neutral reaction trend overlying strongly and coarsely mottled, acid, gleyed clay

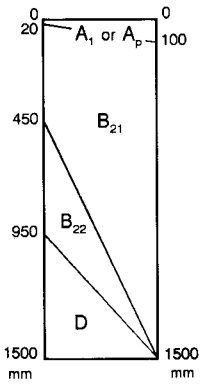
Principal profile forms: Ug5.2, Ug5.1, Ug5.28, Ug5.25, Ug5.24 **Great soil group:** Grey clay and black earth

Parent material: Quaternary alluvium

Landform: Alluvial plains (may be frequently flooded)

Predominant vegetation: Coolibah, tall, open woodland to woodland

Surface features: May have few, fine, quartz and ironstained gravel; cracking and self-mulching



A_1 or A_p: Dark to grey-brown (2.5Y to 7.5YR 3/2, 4/1, 4/2); dark to grey-brown (dry); medium to heavy clay; moderate to strong 2-10 mm subangular blocky occasionally parting to strong <2 mm subangular blocky and granular; dry loose; may have few fine quartz and ironstained gravel; may have very few carbonate nodules; pH 6.0-9.0. Abrupt to clear to -

B_{21}: Grey to dark (2.5Y to 10YR 4/1, 4/2, 3/2); medium to heavy clay; dry very firm to moderately strong; may have few fine to medium quartz and ironstained gravel; may have few carbonate nodules and/or few manganiferous nodules and/or very few gypsum crystals; pH 7.5-8.7. Clear to diffuse to -

B_{22} (where present): Grey to brown (2.5Y to 7.5YR 4/1 to 4/3 and 3/3, 3/4); medium to heavy clay; may have common fine to medium yellow, brown and grey mottles; dry very firm to moderately strong; may have few fine to medium quartz and ironstained gravel; very few to many gypsum crystals and/or very few to many manganiferous veins and nodules; pH 5.5-8.0. Clear to diffuse to -

D: Strongly and coarsely mottled, acid, gleyed clay

Notes: 1. Structure in the B_2 horizons usually changes from angular blocky to lenticular below 250 mm depth.

2. Buried layers of sand may also be present below 1500 mm depth.

KENLOGAN

Major attributes: A self-mulching, red to red-brown, mainly cracking clay with neutral to alkaline reaction trend overlying red tuff below 450 mm depth

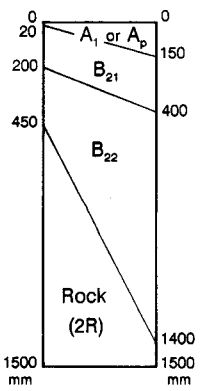
Principal profile forms: Ug5.37, Uf6.31 **Great soil group:** Red clay and no suitable group

Parent material: Probably shallow Tertiary basalt flows

Landform: Gently undulating to level plains

Predominant vegetation: Brigalow, tall to mid-high, open forest to open woodland or Queensland bluegrass, tall, tussock to open tussock grassland

Surface features: May have normal gilgai (vertical interval .05-.20 m, horizontal interval 5-10 m); may have common, fine to medium, quartz and ferruginised gravel and basalt cobble; self-mulching and mainly cracking



A_1 or A_p: Red to red-brown (2.5YR to 5YR 3/3 to 4/6), red to grey-brown (dry); light to medium heavy clay; moderate to strong 2-10 mm subangular blocky parting to strong <2 mm granular; dry loose; may have common carbonate nodules; pH 6.5-9.0. Clear to gradual to -

B_{21}: Red to red-brown (2.5YR to 5YR 3/3 to 4/6); light medium to heavy clay; moderate to strong blocky; dry very firm to very strong; may have few carbonate nodules; pH 6.5-9.0. Clear to gradual to -

B_{22}: As for B_{21} except has strong lenticular structure and may have few gypsum crystals as well. Clear to gradual to -

2R: Red (2.5YR to 10R 3/4 to 5/6); may have common medium prominent yellow and grey mottles; may have very abundant ferruginised, quartz and basalt gravel; may have many carbonate soft segregations and common manganiferous veins; pH 7.5-8.7

KENMAR

Major attributes: A normal, linear and lattice gilgai complex overlying buried layers
Mounds: self-mulching to firm, grey to grey-brown clay with acid to alkaline reaction trend
Depressions: very fine self-mulching, dark to grey-brown, cracking clay with acid to alkaline reaction trend

Principal profile forms: *(mounds):* Uf6.33, Ug5.25, Ug5.24 **Great soil group:** *(mounds):* No suitable group and grey clay
(depressions): Ug5.24, Ug5.15, Ug5.25 *(depressions):* Grey clay and black earth

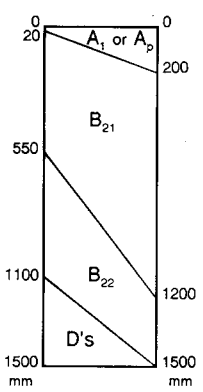
Parent material: Cainozoic unconsolidated sediments

Landform: Level to gently undulating plains

Predominant vegetation: Gidgee and brigalow, tall to mid-high, open forest to woodland

Surface features: Normal, linear and lattice gilgai (vertical interval .05-.25 m, horizontal interval 5-30 m); may have many, fine to coarse, quartz and ironstained gravel; self-mulching to firm (occasionally hard setting) on mounds, cracking and self-mulching in depressions

Mounds



A_1 or A_p: Dark to grey and occasional brown (10YR to 7.5YR 3/2 to 5/2 and occasional 3/3, 4/3), grey to grey-brown (dry); light medium to medium heavy clay; weak to moderate 2-10 mm subangular blocky frequently parting to strong <2 mm subangular blocky and granular; dry very firm to loose; may have common fine to medium quartz and ironstained gravel; may have many carbonate nodules; pH 7.0-9.0. Clear to gradual to -

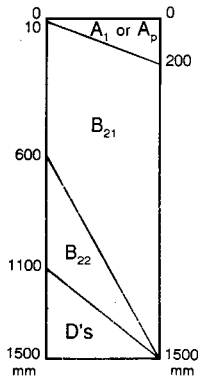
B_{21}: Grey, dark or grey-brown (2.5Y to 7.5YR 3/1 to 6/2); medium to heavy clay; moderate 10-50 mm blocky becoming lenticular with depth; dry very firm to very strong; may have few fine to coarse quartz and ironstained gravel; may have many carbonate nodules and soft segregations, common gypsum crystals and few manganiferous nodules and soft segregations; pH 7.5-9.0. Clear to diffuse to -

B_{22}: Grey to brown (10YR to 7.5YR 5/2 to 4/4 and 6/4); medium heavy to heavy clay; may have common fine to medium distinct grey, red or yellow mottles; strong lenticular; dry very firm to very strong; may have few fine to coarse quartz and ironstained gravel; may have common manganiferous veins, carbonate nodules and soft segregations and gypsum crystals; pH 4.5-9.0. Clear to diffuse to -

D's : EITHER Mixture of clay, weathered sandstone and sand

OR Strongly and coarsely mottled, gley, red and yellow acid clay

Depressions



A_1 or A_p: Dark to grey-brown (10YR to 7.5YR 3/1 to 4/2), dark to grey-brown (dry); light medium to medium heavy clay; weak to moderate 2-10 mm subangular blocky parting to <2 mm granular; dry loose; may have few fine to medium quartz and ironstained gravel; may have few carbonate nodules; pH 7.5-9.0. Clear to gradual to -

B_{21}: Dark to grey-brown (10YR to 7.5YR 3/1 to 5/2); medium heavy to heavy clay; moderate 10-50 mm angular blocky becoming strong lenticular with depth; dry very firm to very strong; may have few fine to medium quartz and ironstained gravel; may have common carbonate nodules and soft segregations and common gypsum crystals; pH 6.0-9.0. Gradual to diffuse to -

B_{22}: Grey to brown (10YR to 7.5YR 5/2 to 4/3); medium heavy to heavy clay; may have many fine to coarse dark, gley and red mottles; strong lenticular; dry very firm to very strong; may have few fine to coarse quartz and ironstained gravel; may have common manganiferous veins, many gypsum crystals and few carbonate nodules and soft segregations; pH 5.0-9.0. Clear to diffuse to -

D's : EITHER Mixture of clay, weathered sandstone and sand

OR Strongly and coarsely mottled, gley, red and yellow acid clay

Notes:
1. Thin bands of sand and individual grains are evident throughout the profiles of both mounds and depressions.
2. The pH decreases with depth in the majority of profiles.
3. The strongly and coarsely mottled clay D? horizon may have neutral pH (7.0-8.0) in the uppermost part.

KENMAR, MELONHOLE PHASE

Major attributes: Similar to Kenmar, except for the following:

- melonhole gilgai (vertical interval .30-1.0 m, horizontal interval 10-30 m);
- may have abundant, fine to coarse, quartz and ironstained gravel on the surface of mounds;
- a generally coarser self-mulching surface in depressions;
- sporadic bleach may be occasionally present below the self-mulch in depressions;
- the strongly and coarsely mottled, acid, gleyed clay may be encountered from 750 mm depth in depressions

LEBANON

Major attributes: A duplex soil with ferruginised gravel and hard setting, dark to brown, loamy sand to sandy clay loam surface, usually with a bleached subsurface, over a generally mottled grey-brown, yellow-brown and red clay subsoil with neutral to alkaline reaction trend overlying ferricrete

Principal profile forms: Dy3.33, Dy3.32, Dy3.43, Dy3.42, Dy2.43, Dy2.12

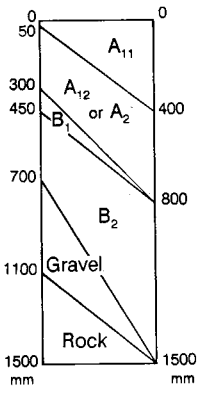
Great soil group: Solodized solonetz and solodic soil, and no suitable group (affinities with solodized solonetz and solodic soil)

Parent material: Cainozoic ferruginised sediments (soil material and gravel)

Landform: Level to gently undulating plains

Predominant vegetation: Poplar box, tall, open woodland to woodland

Surface features: May have common, fine to medium, ferruginised gravel; hard setting



A_{11}: Dark to brown and red (7.5YR to 5YR 3/2, 4/2 to 5/4); grey to brown (dry); loamy sand to sandy clay loam; massive; dry very weak to moderately firm; may have common fine ferruginised gravel; pH 5.8-8.0. Abrupt to gradual to -

A_{12} or A_2: Grey-brown to red (7.5YR to 5YR 4/4 to 6/6), brown to light grey (dry); sand to sandy clay loam; massive; sporadically or conspicuously bleached; dry loose to moderately firm; may have abundant fine to medium ferruginised gravel; pH 5.8-8.0. Abrupt to clear to -

B_1 (where present): Generally mottled grey-brown, yellow-brown and red (5YR to 10YR 6/2 to 6/6); clay loam, sandy to light medium clay; may be sporadically bleached; dry moderately firm to very firm; may have many fine to medium ferruginised gravel; pH 6.0-7.0. Abrupt to gradual to -

B_2: Generally mottled yellow-brown, grey and brown to red (5YR to 10YR 4/6 to 6/8 and 5/2 to 7/2); light medium to medium heavy clay; dry very firm to very strong; may have many fine to medium, ferruginised gravel; may have common manganiferous nodules and veins and few carbonate nodules and soft segregations; pH 7.0-8.7

Notes: 1. The B_2 horizon overlies either ferricrete (rounded ferruginised gravel cemented together by iron oxides) or, occasionally, ferruginised sandstone.

2. The whole coloured profiles (Dy2) have yellow-brown to brown B_2 horizons with few grey mottles.

LEBANON, RED VARIANT

Major attributes: A duplex soil with hard setting, red, light sandy clay loam to clay loam, sandy surface, occasional pale subsurface, over red clay subsoil with neutral to alkaline reaction trend overlying ferricrete

Principal profile forms: Dr2.13, Dr2.12, Dr2.23, Dr2.22

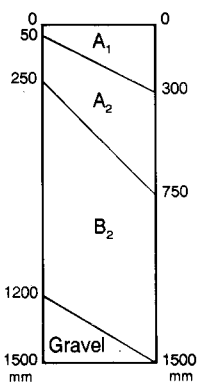
Great soil group: Red-brown earth and non-calcic brown soil

Parent material: Cainozoic ferruginised sediments (soil material and gravel)

Landform: Level plains

Predominant vegetation: Mountain coolibah, tall, open woodland to woodland

Surface features: May have common, fine, ferruginised gravel; hard setting



A_1: Red to dark (2.5YR to 5YR 4/4 to 2/3), red to brown (dry); light sandy clay loam to clay loam, sandy; massive; dry very weak to moderately firm; may have few fine ferruginised gravel; pH 6.0-7.0. Abrupt to gradual to -

A_2 (where present): Red (2.5YR 5/6 to 3/4), red (dry); sandy clay loam to clay loam, sandy; massive; dry moderately weak to moderately firm; may have very few fine ferruginised gravel; pH 6.5-7.0. Clear to gradual to -

B_2: Red (2.5YR to 10R 4/6, 4/8, 5/6); sandy clay to medium clay; may have few fine to medium distinct orange mottles; may have common manganiferous nodules and many carbonate soft segregations; pH 7.5-9.0

Note: Ferricrete (rounded, ferruginised gravel cemented together by iron oxides) may be encountered beneath the B_2 horizon.

MANAR

Major attributes: A very fine self-mulching, red to brown, cracking clay with alkaline reaction trend overlying brightly coloured clay interbedded with layers of weathered basalt

Principal profile forms: Ug5.38, Ug5.34, Ug5.3

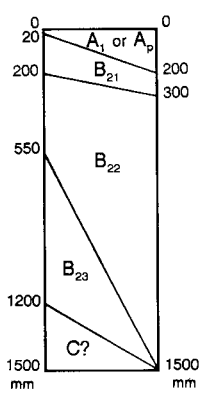
Great soil group: Red and brown clay

Parent material: Cainozoic unconsolidated sediments

Landform: Level plains

Predominant vegetation: Gidgee and brigalow, tall to mid-high, open forest to woodland

Surface features: May have normal gilgai (vertical interval .05-.20 m, horizontal interval 5-10 m); may have few, fine to coarse, ironstained, basalt and quartz gravel; cracking and self-mulching



A_1 or A_p: Red to brown (2.5YR to 7.5YR 3/3 to 4/6), red to brown (dry); light medium to medium heavy clay; moderate to strong 2-10 mm subangular blocky parting to strong <2 mm subangular blocky and granular; dry loose; may have common carbonate nodules; pH 7.5-9.0. Abrupt to clear to -

B_{21}: Red to brown (2.5YR to 7.5YR 3/4 to 4/6); medium to heavy clay; dry moderately firm to moderately strong; may have few fine to medium gravel; may have few carbonate nodules and soft segregations and very few manganiferous nodules; pH 8.0-9.0. Abrupt to diffuse to -

B_{22}: As for B_{21}, except for strong lenticular structure; may have many carbonate nodules and soft segregations. Abrupt to diffuse to -

B_{23} (where present): Red to brown (2.5YR to 7.5YR 3/4 to 5/6); medium to heavy clay; dry moderately firm to moderately strong; may have few fine to medium ironstained, basalt and quartz gravel; very few to common gypsum crystals and/or few to many manganiferous veins and may have common carbonate nodules and soft segregations; pH 7.8-9.0. Clear to gradual to -

C?: Brown and red clay; may have 50% brown red yellow and gley mottles; may have common fine to medium basalt, ironstained and quartz gravel; pH 7.7-8.7

Note: Melonhole gilgai (vertical interval .35-.40 m, horizontal interval 10 m) may occur rarely.

MARACONDA

Major attributes: A coarse self-mulching, grey, cracking clay with acid reaction trend overlying strongly and coarsely mottled, acid, gleyed clay

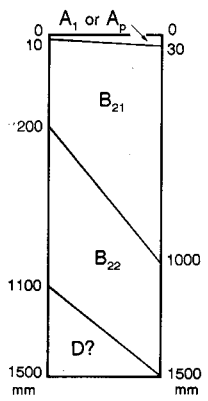
Principal profile forms: Ug5.25, Ug5.24, Ug5.29 **Great soil group:** Grey clay

Parent material: Cainozoic unconsolidated sediments

Landform: Level plains

Predominant vegetation: Queensland blue-grass-Mitchell grasses, tall, tussock to open tussock grassland

Surface features: May have normal gilgai (vertical interval .05-.20 m, horizontal interval 1-2 m); may have few, fine, quartz and ironstained gravel; cracking and self-mulching



A_1 or A_p: Grey to grey-brown (2.5Y to 7.5YR 4/1, 4/2), grey (dry); medium heavy to heavy clay; moderate to strong 5-20 mm subangular blocky, occasionally parting to <2 mm subangular blocky and granular; dry loose; may have very few fine quartz gravel; pH 6.0-7.0. Abrupt to gradual to -

B_{21}: Grey to grey-brown (2.5Y to 7.5YR 4/1, 4/2); medium heavy to heavy clay; dry very firm to moderately strong; may have very few carbonate nodules; pH 6.0-8.0. Abrupt to gradual to -

B_{22}: Red-brown to grey (5YR to 2.5Y 4/3 to 4/1); medium heavy to heavy clay; may have common fine to medium red, gley and yellow mottles; strong lenticular structure; dry very firm to moderately strong; very few to common gypsum crystals and may have common manganiferous veins; pH 4.5-7.0. Gradual to diffuse to -

D?: Strongly and coarsely mottled, gley, red and yellow acid clay

Note: Structure in the B_{21} horizon changes from moderate to strong 20-100 mm blocky to strong lenticular with depth.

MARTYR

Major attributes: A normal, lattice and linear gilgai complex overlying cemented gravel and sandy clay
Mounds: a hard setting to self-mulching, grey to brown clay with neutral to alkaline reaction trend
Depressions: self-mulching, dark to grey, cracking clay with neutral to alkaline reaction trend

Principal profile forms: *(mounds):* Uf6.33, Ug5.2, Ug5.24, Ug5.28, Uf6.31 **Great soil group:** *(mounds):* No suitable group and grey clay

(depressions): Ug5.16, Ug5.15, Ug5.2 *(depressions):* Black earth and grey clay

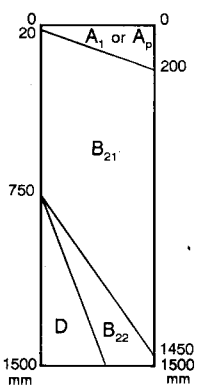
Parent material: Cainozoic unconsolidated sediments

Landform: Level plains

Predominant vegetation: Gidgee and brigalow, tall to mid-high, open forest to woodland or boree, tall to mid-high, woodland to open forest or coolibah, tall, open woodland to woodland

Surface features: Normal, linear and lattice gilgai (vertical interval .05-.25 m, horizontal interval 5-15 m); may have abundant, fine to coarse, quartz and ironstained gravel; hard setting to self-mulching (and occasionally cracking) on mounds, cracking and self-mulching in depressions

Mounds



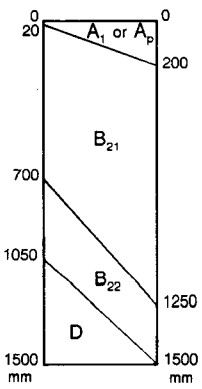
A_1 or A_p: Grey to brown (2.5Y to 7.5YR 4/1 to 4/3), grey to grey-brown (dry); sandy to medium heavy clay; massive to strong <2 mm granular; dry moderately firm to loose; may have common fine quartz and ironstained gravel; may have many carbonate nodules; pH 7.0-8.5. Abrupt to gradual to -

B_{21}: Grey to brown (2.5Y to 7.5YR 4/1 to 4/3); medium to heavy clay; moderate to strong structure; dry very firm to very strong; may have few fine quartz and ironstained gravel; may have common carbonate nodules and soft segregations; pH 7.5-9.0. Abrupt to diffuse -

B_{22} (where present): Brown to grey (7.5YR to 2.5Y 5/6 to 4/2); medium to heavy clay; may have common fine to medium distinct grey, brown and dark mottles; dry very firm to very strong; may have common fine to medium quartz and ironstained gravel; may have common carbonate nodules and soft segregations, common gypsum crystals and common manganiferous veins; pH 7.0-8.7. Clear to diffuse to -

D: Cemented gravel and/or sandy clay

Depressions



A_1 or A_p: Dark to grey-brown (2.5Y to 7.5YR 3/1 to 4/2), dark to grey-brown (dry); medium to medium heavy clay; strong 2-10 mm subangular frequently blocky parting to <2 mm subangular blocky and granular; dry loose; may have common fine quartz and ironstained gravel; may have common carbonate nodules; pH 6.0-8.7. Abrupt to clear to -

B_{21}: Dark to grey (2.5Y to 10YR 2/1 to 4/2); medium heavy to heavy clay; dry very firm to very strong; may have common carbonate nodules, and many gypsum crystals at depth; pH 7.0-9.0. Gradual to diffuse to -

B_{22}: Brown to grey (5YR to 10YR 5/4 to 4/2); medium to heavy clay; may have 50% fine to coarse distinct dark, brown, grey and yellow mottles; dry very firm to moderately strong; may have few fine to medium quartz and ironstained gravel; may have common carbonate nodules and soft segregations, many gypsum crystals and few manganiferous nodules; pH 7.5-9.0. Abrupt to diffuse to -

D: Cemented gravel and/or sandy clay

Notes:

1. Gilgai may be absent in small areas, especially in close proximity to other soils.
2. Structure appears to change in the B_{21} horizon from moderate to strong 10-50 mm blocky to lenticular between 200 and 400 mm depth beneath both mounds and depressions.
3. The D horizon contains sandy clay (with or without fine to coarse gravel) and/or a layer of cemented, fine to coarse gravel. The loose and cemented gravel consist of quartz, basalt and other ironstained gravel.

MIDDEN

Major attributes: A lattice, normal and linear gilgai complex overlying buried layers
Mounds: very fine self-mulching to hard setting, brown to red-brown clay with neutral to alkaline reaction trend
Depressions: self-mulching, dark to grey-brown, cracking clay with acid to alkaline reaction trend

Principal profile forms: *(mounds):* Uf6.31, Uf6.33, Ug5.35, Uf6.4, Ug5.2
(depressions): Ug5.24, Ug5.16, Ug5.15, Ug5.25

Great soil group: *(mounds):* No suitable group and brown and grey clay
(depressions): Grey clay and black earth

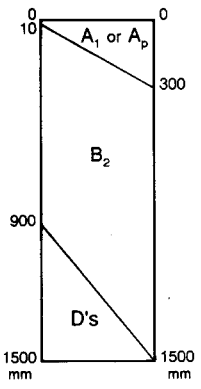
Parent material: Cainozoic unconsolidated sediments

Landform: Gently undulating plains

Predominant vegetation: Gidgee and brigalow, tall to mid-high, open forest to woodland

Surface features: Lattice, normal and linear gilgai (vertical interval .05-.30 m, horizontal interval 5-25 m); may have common, fine to coarse, quartz and ironstained gravel; self-mulching to hard setting (and occasionally cracking) on mounds, cracking and self-mulching in depressions

Mounds



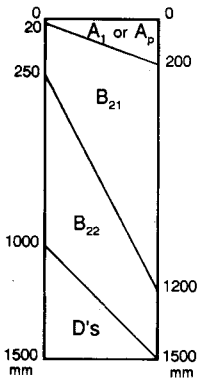
A_1 or A_p: Brown to red and occasional dark (7.5YR to 2.5YR 3/3 to 4/4 and occasional 3/2), grey-brown to red (dry); clay loam, sandy to medium clay; massive to moderate <2 mm subangular blocky; dry moderately weak to loose; may have common fine to medium quartz and ironstained gravel; may have many carbonate nodules; pH 6.0-9.0. Abrupt to gradual to -

B_2: Brown to red-brown and occasional red (10YR to 5YR 3/3 to 5/6 and occasional 2.5YR 3/4 t0 5/6); medium to medium heavy clay; may have many medium distinct yellow, grey, brown and red mottles; dry very firm to very strong; may have common quartz and ironstained gravel; may have many carbonate nodules and soft segregations, may have few gypsum crystals and/or common manganiferous veins and nodules; pH 6.5-9.0. Clear to gradual to -

D's : EITHER Mixture of clay, weathered sandstone and sand

OR Strongly and coarsely mottled, gley, red and yellow acid clay

Depressions



A_1 or A_p: Dark to grey-brown (2.5Y to 5YR 3/1 to 5/2), dark to grey-brown (dry); light medium to medium heavy clay; weak to strong 2-10 mm subangular blocky parting to <2 mm granular; dry loose; may have few fine to coarse quartz and ironstained gravel; may have few carbonate nodules; pH 7.0-9.0. Clear to gradual to -

B_{21}: Dark to grey-brown (2.5Y to 5YR 3/1 to 5/3); medium heavy to heavy clay; may have few medium brown mottles; moderate angular blocky becoming strong lenticular with depth; dry very firm to moderately strong; may have few fine to medium quartz and ironstained gravel; may have many carbonate nodules and soft segregations, common gypsum crystals and few manganiferous nodules; pH 6.5-9.0. Clear to diffuse to -

B_{22}: Grey to red-brown (10YR to 5YR 4/2 to 5/4); medium heavy to heavy clay; may have many distinct gley, brown, yellow and red mottles; strong lenticular; dry very firm to moderately strong; may have few fine to medium quartz and ironstained gravel; may have many carbonate nodules and soft segregations and/or common gypsum crystals and/or many manganiferous veins; pH 5.0-8.7. Clear to diffuse to -

D's : EITHER Mixture of clay, weathered sandstone and sand

OR Strongly and coarsely mottled, gley, red and yellow acid clay

Notes:
1. Thin bands of sand and individual sand grains are evident throughout the profiles of both mounds and depressions.
2. There is no consistent trend with depth for soil colour, pH or segregations in the B_2 horizon beneath the mounds.
3. The strongly and coarsely mottled clay D? horizon may have a neutral to alkaline pH (7.0-8.7) in the uppermost part.

MIDDEN, MELONHOLE PHASE

Major attributes: Similar to **Midden**, except for the following:

- melonhole gilgai (vertical interval .35-1.30 m, horizontal interval 10-20 m);
- very few to many, fine to coarse, quartz and ironstained gravel on the surface of mounds and depressions;
- a generally coarser self-mulching surface in depressions;
- sporadic bleach may be occasionally present below the self-mulch in depressions;
- the strongly and coarsely mottled, acid, gleyed clay may be encountered below 600 mm depth in depressions

MISCELLANEOUS SOILS

Major attributes: A range of duplex soils with hard setting, loamy sand to clay loam surface soils and bleached subsurfaces over alkaline to neutral clay subsoils overlying unconsolidated sediments

Principal profile forms: Dd1.43, Dy3.43, Dy3.32

Great soil group: Solodized solonetz and solodic soil

Parent material: Quaternary alluvium

Landform: Valley flats (may be frequently flooded)

Notes: The few profiles described indicate that these soils form part of Retro, Wyseby and possible Luxor soil families identified by Gunn (1967a, 1967b).

MORAMANA

Major attributes: A self-mulching, grey to red-brown, cracking clay with alkaline to neutral reaction trend overlying unconsolidated sediments or buried rock

Principal profile forms: Ug5.25, Ug5.34, Ug5.38, Ug5.24, Ug5.3, Ug5.2

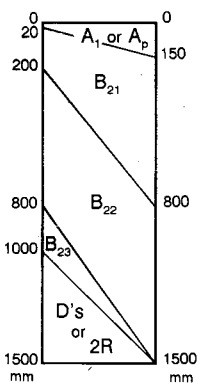
Great soil group: Grey, brown and red clay

Parent material: Quaternary alluvium

Landform: Alluvial plains (may be frequently flooded)

Predominant vegetation: Coolibah, tall, open woodland to woodland

Surface features: May have normal gilgai (vertical interval .05-.20 m, horizontal interval 1-5 m); may have common, quartz, basalt and ironstained fine gravel to cobble; cracking and self-mulching



A_1 or A_p: Grey to red-brown (10YR to 5YR 3/3 to 4/4 and 4/2), grey to red-brown (dry); light to medium heavy clay; moderate to strong 2-10 mm subangular blocky occasionally parting to moderate to strong <2 mm subangular blocky and granular; dry loose; may have few fine to medium quartz, basalt and ironstained gravel; may have common carbonate nodules; pH 8.0-9.0. Abrupt to gradual to -

B_{21}: Grey to red-brown (10YR to 5YR 3/3 to 4/4 and 4/2); medium to heavy clay; moderate 10 to >50 mm blocky, dry moderately firm to moderately strong; may have few fine to medium quartz, basalt and ironstained gravel; may have common carbonate nodules and common manganiferous nodules; pH 8.0-9.0. Abrupt to diffuse to -

B_{22}: As for B_{22}, except for strong lenticular structure; may have many carbonate nodules and soft segregations and common manganiferous nodules; pH 8.5-9.0. Abrupt to diffuse to -

B_{23} (where present): Red-brown to grey (5YR to 10YR 3/3 to 5/6 and 4/2); medium to heavy clay; may have common distinct yellow, grey, brown and red mottles; lenticular structure; dry moderately firm to moderately strong; may have common fine to coarse quartz, basalt and ironstained gravel; very few to common gypsum crystals and/or few to common manganiferous veins and nodules and may have common carbonate nodules and soft segregations; pH 7.5-8.7. Clear to diffuse to -

EITHER D's: Clay with sand; may be mottled; may have common basalt gravel; pH 7.5-9.0

OR 2R: Basalt rock

Notes:

1. Profiles may occasionally have dark A, B_{21} and B_{22} horizons (Ug 5.15, Ug5.1).
2. The D's may include strongly and coarsely mottled, gleyed, clay which is alkaline in the upper part and acid at depth.
3. A variant with silty clay surface textures may occur on isolated levees.

MORAMANA, GILGAI PHASE

Major attributes: A linear and lattice gilgai complex overlying cemented gravel and sandy clay

Mounds: very fine self-mulching, red-brown to brown, cracking clay with alkaline reaction trend
Depressions: self-mulching, grey to red-brown and occasionally dark, cracking clay with alkaline reaction trend

Principal profile forms: *(mounds):* Ug5.3, Ug5.34, Ug5.38
(depressions): Ug5.2, Ug5.25, Ug5.3, Ug5.17

Great soil group: *(mounds):* Brown and red clay
(depressions): Grey and brown clay and black earth

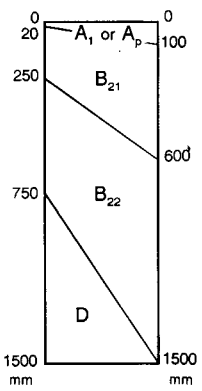
Parent material: Quaternary alluvium

Landform: Alluvial plains (may be relict from flooding)

Predominant vegetation: Coolibah or mountain coolibah, tall, open woodland to woodland

Surface features: Linear and lattice gilgai complex (vertical interval .05-.30 m, horizontal interval 5-15 m); may have many, fine to coarse, quartz, basalt and ironstained gravel; cracking and self-mulching

Mounds



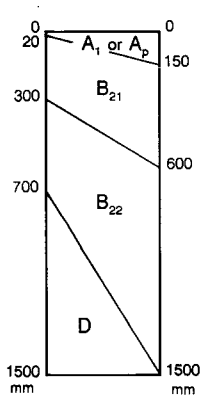
A_1 or A_p: Red-brown to grey-brown (5YR to 7.5YR 4/4 to 4/2, 3/3 and 10YR 3/3, 3/4), red-brown to grey-brown (dry); light medium to medium heavy clay; moderate to strong 2-10 mm subangular blocky parting to strong <2 mm granular and subangular blocky; dry loose; may have many carbonate nodules; pH 8.0-9.0. Abrupt to gradual to -

B_{21}: Red-brown to brown (5YR to 10YR 4/3, 3/3, 4/4, 3/4); medium to heavy clay; moderate 10-50 mm blocky; dry moderately firm to moderately strong; may have common fine to coarse quartz, basalt and ironstained gravel; very few to many carbonate nodules and soft segregations; pH 8.5-9.0. Clear to diffuse to -

B_{22}: Red-brown to grey-brown (5YR to 7.5YR 5/6 to 3/4, 4/2 and 10YR 3/3, 4/3); medium to heavy clay; may have common distinct fine to medium grey and yellow mottles; strong lenticular; dry moderately firm to moderately strong; may have common fine to coarse quartz, basalt and ironstained gravel; very few to many carbonate nodules and soft segregations and may have common manganiferous veins and nodules and few gypsum crystals; pH 8.0-8.7. Clear to gradual to -

D: Cemented gravel and/or sandy clay; few to very many carbonate nodules and soft segregations

Depressions



A_1 or A_p: Grey to red-brown and occasional dark (10YR to 5YR 4/1 to 3/3 and occasional 3/1), grey-brown to dark (dry); medium to medium heavy clay; dry loose; strong 2-10 mm subangular blocky occasionally parting to <2 mm subangular blocky and granular; may have few carbonate nodules; pH 7.5-8.5. Abrupt to gradual to -

B_{21}: Grey to red-brown and occasional dark (10YR to 5YR 4/1 to 3/3 and occasional 3/1); medium to heavy clay; dry moderately firm to moderately strong; may have very few fine quartz, basalt and ironstained gravel; may have few carbonate nodules and soft segregations; pH 8.0-8.7. Clear to gradual to -

B_{22}: Grey to red-brown and occasional dark (10YR to 5YR 5/4 to 4/2 and occasional 3/1); medium to heavy clay; may have common medium yellow, dark and grey mottles; strong lenticular; dry very firm to moderately strong; may have few fine to medium quartz, basalt and ironstained gravel; may have many carbonate nodules and soft segregations and few manganiferous veins and nodules; pH 8.0-9.0. Abrupt to diffuse to -

D: Cemented gravel and/or sandy clay; few to very many carbonate nodules and soft segregations

Note: Some mound profiles have only very weak periodic cracking and may be classified as non-cracking (Uf6.31).

NIAGARA

Major attributes: A very fine self-mulching, red to brown, cracking clay with alkaline reaction trend overlying basalt below 900 mm depth

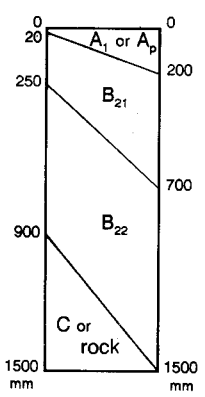
Principal profile forms: Ug5.37, Ug5.38, Ug5.32, Ug5.34 **Great soil group:** Red and brown clay

Parent material: Tertiary basalt

Landform: Gently undulating to level plains

Vegetation: Gidgee and brigalow, tall to mid-high, open forest to woodland

Surface features: May have incipient normal gilgai (vertical interval .05-.15 m, horizontal interval 5-20 m); may have few, fine to coarse, quartz and ferruginised gravel and common, coarse basalt gravel to stone; cracking and self-mulching



A_1 or A_p: Brown to red (2.5YR to 7.5YR 3/4 to 5/6),grey-brown to red (dry); light to medium heavy clay; strong <2 mm granular; dry loose; may have common carbonate nodules; pH 7.5-9.0. Abrupt to gradual to -

B_{21}: Red to brown (2.5YR to 7.5YR 3/4 to 5/6); medium to medium heavy clay; moderate to strong blocky; dry very firm to moderately strong; may have few fine to medium gravel; may have many carbonate nodules; pH 7.5-9.0. Clear to diffuse to -

B_{22}: As for B_{21} except has strong lenticular structure and may have few gypsum crystals; pH 8.0-9.0

Note: A few profiles have grey-brown colours (5YR to 7.5YR 5/3 and 5/4) and may be classified as Ug5.22.

NUNGAROO

Major attributes: A melonhole and normal gilgai complex overlying strongly and coarsely mottled, acid, gleyed clay
Mounds: hard setting to self-mulching, red-brown to grey-brown clay with acid to alkaline reaction trend
Depressions: self-mulching, grey-brown, cracking clay with acid reaction trend

Principal profile forms: *(mounds):* Uf6.31, Ug5.3, Uf6.33, Ug5.25 **Great soil group:** *(mounds):* No suitable group and brown clay
(depressions): Ug5.24, Ug5.25, Ug5.3 *(depressions):* Grey and brown clay

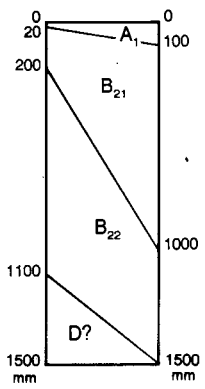
Parent material: Cainozoic unconsolidated sediments

Landform: Level plains

Predominant vegetation: Gidgee and brigalow, tall to mid-high, open forest to woodland

Surface features: Melonhole and normal gilgai (vertical interval .15-.60 m, horizontal interval 5-20 m); few to common, fine to medium, quartz and ironstained gravel on mounds, may have few, fine to medium, quartz and ironstained gravel in depressions; hard setting to self-mulching (and occasionally cracking) on mounds, cracking and self-mulching in depressions

Mounds



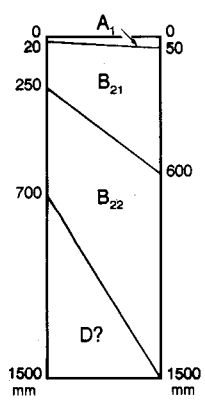
A_1: Red-brown to grey-brown (5YR to 7.5YR 5/4 to 4/2 and 3/3), red-brown to grey-brown (dry); fine sandy clay to medium clay; weak to moderate 2-10 mm subangular blocky occasionally parting to strong <2 mm granular; dry moderately firm to loose; may have few fine to medium quartz and ironstained gravel; may have few carbonate nodules; pH 6.0-9.0. Clear to gradual to -

B_{21}: Red-brown to grey-brown (5YR to 7.5YR 5/4 to 4/2 and 3/4); medium to heavy clay; dry very firm to very strong; may have few fine to medium quartz and ironstained gravel; may have common carbonate nodules and soft segregations; pH 7.5-9.0. Clear to diffuse to -

B_{22}: As for B_{21}, except for strong lenticular structure; may have common distinct gley mottles at depth; very few to many gypsum crystals and/or common manganiferous veins and may have few carbonate soft segregations; pH 5.0-8.7. Clear to diffuse to -

D?: Strongly and coarsely mottled, gley, red and yellow acid clay

Depressions



A_1: Grey to brown (7.5YR to 10YR 4/2 to 4/4 and 5/3); grey to brown (dry); medium to medium heavy clay; moderate to strong 2-10 mm subangular blocky occasionally parting to moderate to strong <2 mm subangular blocky and granular; dry loose; may have few fine to medium quartz and ironstained gravel; pH 6.0-9.0. Clear to gradual to -

B_{21}: Grey-brown to brown (7.5YR 4/2 to 5/3 and 3/3); medium heavy clay; may have many distinct orange, gley and brown mottles; moderate to strong 10-50 mm blocky; dry moderately strong; may have few fine to medium quartz and ironstained gravel; may have few carbonate nodules; pH 6.0-9.0. Clear to diffuse to -

B_{22}: Grey-brown to red-brown (7.5YR to 5YR 3/3 to 5/4 and 4/4); medium heavy to heavy clay; may have few distinct gley, brown and orange mottles; strong lenticular; may have common gypsum crystals and few manganiferous soft segregations; pH 4.5-6.0. Gradual to diffuse to -

D?: Strongly and coarsely mottled, gley, red and yellow acid clay

Notes: 1. The structure in the B_{21} horizon beneath the mounds changes from 10-50 mm blocky to lenticular between 150 and 500 mm depth.

2. Thin bands of sand are evident throughout both mound and depression profiles.

OK

Major attributes: A hard setting, red to grey-brown clay with alkaline to neutral reaction trend overlying ferricrete and weathered clay below 500 mm depth

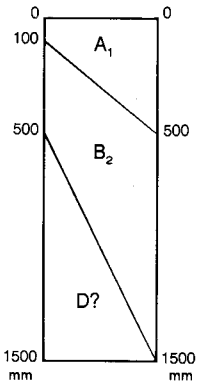
Principal profile forms: Uf6.31, Uf6.33, Uf6.34 **Great soil group:** No suitable group

Parent material: Cainozoic ferruginised sediments (soil material and gravel)

Landform: Gently undulating plains and rises

Predominant vegetation: Gidgee and brigalow, tall to mid-high, open forest to woodland

Surface features: May have many, fine to medium gravel; hard setting



A_1: Red to brown (2.5YR to 7.5YR 3/3 to 5/6), red-brown to brown (dry); sandy clay to medium clay; weak to moderate 2-10 mm subangular blocky; dry moderately firm to very firm; may have many medium gravel; pH 6.5-8.7. Clear to gradual to -

B_2: Red to brown (2.5YR to 7.5YR 3/6 to 5/6 and 5/3 to 5/4); medium to medium heavy clay; moderate to strong structure; dry very firm to very strong; may have few fine to medium gravel; may have abundant carbonate soft segregations, few gypsum crystals and common manganiferous veins; pH 6.5-9.0. Clear to diffuse to -

D?: Ferricrete (rounded, ferruginised gravel cemented together by iron oxides) and/or mottled red, gleyed and yellow clay

OK, GRAVEL PHASE

Major attributes: A gravelly, hard setting, red to red-brown, clay and gradational soil with neutral reaction trend overlying ferricrete and weathered clay from 200 mm depth

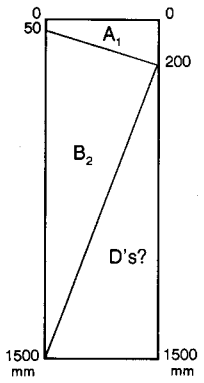
Principal profile forms: Uf6, Uf6.31, Gn3.12 **Great soil group:** No suitable group

Parent material: Cainozoic ferruginised sediments (soil material and gravel)

Landform: Gently undulating rises

Predominant vegetation: Gidgee and brigalow, tall to mid-high, open forest to woodland

Surface features: Common to abundant, fine to coarse gravel; hard setting



A_1: Red to grey-brown (2.5YR to 7.5YR 4/3 to 4/2), red to brown (dry); clay loam to sandy clay; massive to weak structure; dry very weak to moderately firm; very few to abundant fine to coarse gravel; pH 6.7-8.5. Clear to gradual to -

B_2 (where present): Red to red-brown (2.5YR to 5YR 3/4 to 5/6); sandy clay to medium clay; moderate to weak structure; dry very firm to very strong; few to abundant fine to coarse gravel; pH 6.0-8.0. Abrupt to clear to -

D's?: Ferricrete (rounded, ferruginised gravel cemented together by iron oxides) and/or buried layers of gravelly red to red-brown clay

Note: Ferruginised sandstone may occur below the D horizons especially at positions adjacent to **Villafranca** soil.

RANKIN

Major attributes: A very fine self-mulching, grey to grey-brown, cracking clay with alkaline reaction trend overlying mottled, light grey and light yellow orange clay below 900 mm depth

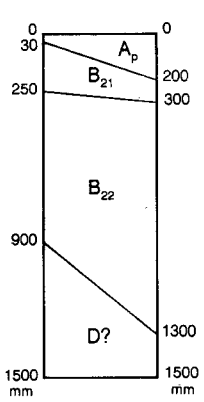
Principal profile forms: Ug5.22, Ug5.27 **Great soil group:** Grey clay

Parent material: Probably, shallow Tertiary basalt flows

Landform: Level to gently undulating plains

Predominant vegetation: Completely cleared and cultivated; formerly gidgee and brigalow, tall to mid-high, open forest to woodland

Surface features: May have common, fine to medium gravel; cracking and self-mulching



A_p: Grey (7.5YR to 10YR 4/2,5/2), grey (dry); light medium to medium heavy clay; strong <2 mm granular; dry loose; may have few carbonate nodules; pH 8.5-9.0. Clear to -

B_{21}: Grey to grey-brown (7.5YR to 2.5Y 4/2 to 5/3); medium heavy clay; dry very firm to moderately strong; may have few carbonate nodules; pH 8.5-9.0. Clear to -

B_{22}: As for B_{21} except has strong lenticular structure and may have common carbonate nodules. Clear to gradual to -

D?: Mottled grey, light grey and light yellow orange clay

Notes:
1. Redder colours may be evident in B_2 horizons where this soil grades towards a **Russell**.
2. Gypsum may occur at the transition to the D? horizon.

RUSSELL

Major attributes: A self-mulching, grey-brown to red-brown, cracking clay with alkaline reaction trend overlying basalt below 400 mm depth

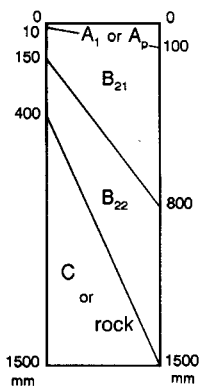
Principal profile forms: Ug5.22, Ug5.32, Ug5.37 **Great soil group:** Grey, brown and red clay

Parent material: Tertiary basalt

Landform: Gently undulating to level plains

Vegetation: Queensland bluegrass, tall, tussock to open tussock grassland or gum topped bloodwood, tall to mid-high, or mountain coolibah, tall, open woodland to woodland

Surface features: May have few fine gravel to stone; cracking and self-mulching



A_1 or A_p: Red-brown to dark (5YR to 10YR 4/3 to 3/2) red-brown to dark (dry); medium to medium to heavy clay; strong 2-10 mm subangular blocky occasionally parting to strong <2 mm granular; dry loose; may have common gravel to stone; may have common carbonate nodules; pH 7.0-8.7, abrupt to gradual to -

B_{21}: Grey-brown to red-brown (7.5YR to 5YR 3/3, 4/1 to 4/3) and occasional grey (10YR 4/1 to 4/2); medium heavy to heavy clay; strong 10-50 mm blocky; dry very firm to moderately strong; may have few fine to medium gravel; may have few carbonate nodules; pH 8.0 to 8.7. Clear to diffuse to -

B_{22}: As for B_{21} except has strong lenticular structure and may have common carbonate nodules and soft segregations

Notes:
1. A massive, very strong hardpan (A_{p2}) may occur below the A_p horizon at 100-150 mm depth.
2. Occasionally, profiles with dark colours (Ug5.12, 5.13) may be encountered.

RUSSELL, GILGAI PHASE

Major attributes: A linear and lattice gilgai, self-mulching, red-brown to grey-brown, cracking clay with alkaline reaction trend overlying basalt below 800 mm depth

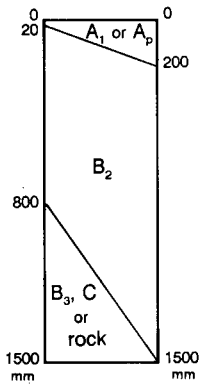
Principal profile forms: Ug5.37, Ug5.22, Ug5.38, Ug5.25 **Great soil group:** Grey, brown and red clay

Parent material: Tertiary basalt

Landform: Level to gently undulating plains

Predominant vegetation: Gum topped bloodwood, tall to mid-high, open woodland to woodland or Queensland bluegrass, tall, tussock grassland to open tussock grassland

Surface features: Linear and lattice gilgai (vertical interval .05-.30 m, horizontal interval 5-10 m); cracking and self-mulching



A_1 or A_p: Red-brown to grey (5YR to 10YR 4/4 to 4/2), red-brown to grey-brown (dry); medium to medium heavy clay; moderate to strong 2-10 mm subangular blocky parting to strong <2 mm granular; dry loose; very few to many carbonate nodules; pH 8.7-9.0. Abrupt to clear to -

B_2: Red-brown or grey (5YR to 10YR 4/4 to 4/2); medium to medium heavy clay; strong blocky to lenticular structure; dry very firm to moderately strong; few to many carbonate nodules and soft segregations; pH 8.7-9.0

Notes:
1. The B_2 horizon may be further subdivided on the basis of structure and colour changes with depth.
2. Carbonate nodules are generally more abundant in the surface soil of mounds than depressions.

RUSSELL, STONY PHASE

Major attributes: Similar to **Russell** except for the presence of common to abundant cobble and stone on the surface

SOLFERINO

Major attributes: A very fine self-mulching, red-brown to grey-brown and occasionally grey, cracking clay with alkaline to neutral reaction trend overlying unconsolidated sediments or buried rock

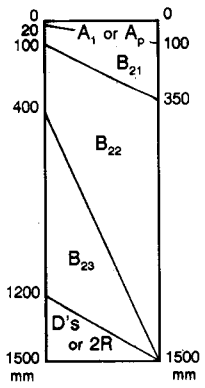
Principal profile forms: Ug5.34, Ug5.39, Ug5.38, Ug5.24, Ug5.3 **Great soil group:** Red, brown and grey clay

Parent material: Quaternary alluvium

Landform: Alluvial plains (may be frequently flooded)

Predominant vegetation: Gidgee and brigalow, tall to mid-high, open forest to woodland

Surface features: May have incipient normal gilgai (vertical interval .05-.10 m, horizontal interval 1-10 m); may have few, fine to medium, quartz, basalt and ironstained gravel; cracking and self-mulching



A_1 or A_p: Red-brown to grey (5YR to 10YR 4/4 to 3/3 and 4/2), red-brown to grey (dry); light medium to medium heavy clay; weak to strong 2-10 mm subangular blocky parting to strong <2 mm subangular blocky and granular; dry loose; may have very few fine quartz and ironstained gravel; may have common carbonate nodules; pH 7.5-9.0. Abrupt to gradual to -

B_{21}: Red-brown to grey-brown and occasional grey (5YR to 7.5YR 5/4 to 4/2, 3/3 and 10YR 4/2); medium heavy to heavy clay; moderate to strong 10-50 mm blocky; dry moderately firm to moderately strong; may have few fine quartz and ironstained gravel; may have common carbonate nodules and soft segregations; pH 7.0-9.0. Clear to diffuse to -

B_{22}: As for B_{21}, except for strong lenticular structure; pH 8.0-9.0. Abrupt to diffuse to -

B_{23}: Red-brown to brown and occasional grey (2.5YR to 7.5YR 5/6 to 4/3 and 10YR 4/2); medium to heavy clay; may have common distinct pale, grey, red and yellow mottles; strong lenticular; dry moderately firm to moderately strong; may have few fine to medium quartz and ironstained gravel; very few to many gypsum crystals and/or very few to many manganiferous veins and nodules and may have many carbonate nodules and soft segregations; pH 6.5-9.0. Abrupt to gradual to -

EITHER D's: Mottled brown to red-brown clay with sand; few to common distinct yellow and dark mottles; pH 8.0-8.5

OR 2R: Basalt rock

VICENZA

Major attributes: A very fine self-mulching, grey to grey-brown, cracking clay with acid to alkaline reaction trend either overlying buried clay layers or overlying strongly and coarsely mottled, acid, gleyed clay

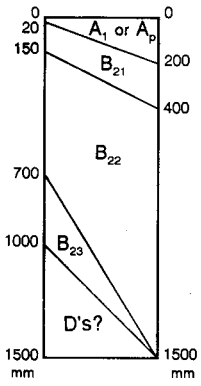
Principal profile forms: Ug5.24, Ug5.25, Ug5.2, Ug5.28, Ug5.29 **Great soil group:** Grey clay

Parent material: Cainozoic unconsolidated sediments

Landform: Level plains

Predominant vegetation: Gidgee and brigalow, tall to mid-high, open forest to woodland

Surface features: May have normal and occasionally lattice gilgai (vertical interval .05-.25 m, horizontal interval 3-15 m); may have few, fine to coarse, quartz, basalt and ironstained gravel; cracking and self-mulching



A_1 or A_p: Dark to grey-brown and occasional brown (2.5Y to 7.5YR 3/2 to 5/2 and occasional 4/3), grey to brown (dry); medium to medium heavy clay; moderate to strong 2-10 mm subangular blocky parting to <2 mm granular and subangular blocky; dry loose; may have few fine to medium quartz and ironstained gravel; may have common carbonate nodules; pH 6.5-9.0. Clear to gradual to -

B_{21}: Grey to grey-brown (2.5Y to 7.5YR 4/1 to 5/3); medium heavy to heavy clay; moderate 5-50 mm blocky; dry very firm to very strong; may have few fine to medium quartz and ironstained gravel; may have common carbonate nodules and soft segregations; pH 8.0-9.0. Clear to diffuse to -

B_{22}: As for B_{21}, except for strong lenticular structure; may have common fine to medium brown and red mottles; may have common carbonate nodules and soft segregations, common gypsum crystals and few manganiferous veins; pH 7.0-9.0. Clear to diffuse to -

B_{23} (where present): Grey-brown to red and occasional grey (10YR to 2.5YR 4/3, 5/2 to 5/6); medium to heavy clay; may have 50% fine to medium distinct grey, brown, yellow and red mottles; strong lenticular; dry moderately firm to very strong; may have few fine to medium quartz, basalt and ironstained gravel; may have many gypsum crystals, many manganiferous veins and common carbonate nodules and soft segregations; pH 5.5-8.7. Clear to diffuse to -

D's?: EITHER Grey-brown to red-brown clay (generally sandy); may have many yellow, red and grey mottles; may have many fine to coarse basalt, quartz and ironstained gravel; pH 6.5-8.7

OR Strongly and coarsely mottled, gley, red and yellow, acid clay

Notes:
1. The pH usually decreases in the deep subsoil of all profiles regardless of the type of underlying D horizons.
2. Rarely, the B_{21} and B_{22} horizons may be dark coloured (Ug5.15, Ug5.16).
3. A few profiles may have brown B_{21} and B_{22} horizons (Ug5.3), especially where adjacent to other brightly coloured soils.

VILLAFRANCA

Major attributes: A hard setting, red, massive, gradational soil with acid to neutral reaction trend overlying ferricrete

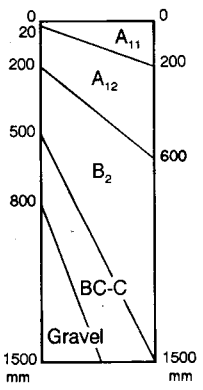
Principal profile forms: Gn2.11, Gn2.12, Um5.52 **Great soil group:** Red earth

Parent material: Cainozoic ferruginised sediments (soil material and gravel)

Landform: Level plains

Predominant vegetation: Queensland grey ironbark, tall to mid-high, open woodland to woodland

Surface features: May have few, fine, ferruginised gravel; hard setting



A_{11}: Red to brown (2.5YR to 7.5YR 3/3 to 4/4), red to brown (dry); loamy sand to clay loam, sandy; massive; dry very weak to moderately weak; may have few fine to medium ferruginised gravel; pH 5.0-7.0. Clear to diffuse to -

A_{12} (where present): Red (10R to 5YR 3/4 to 4/6), red to red-brown (dry); loamy sand to clay loam, sandy; massive to weak structure; dry very weak to moderately firm; may have few fine to medium ferruginised gravel; pH 6.0-7.0. Gradual to diffuse to -

B_2: Red (10R to 5YR 3/4 to 4/6); light sandy clay loam to sandy clay; massive to weak structure; dry moderately weak to very firm; may have few fine to medium ferruginised gravel; pH 6.0-7.5. Clear to diffuse to -

BC (where present): Red to brown (2.5YR to 7.5YR 4/4 to 5/8); loamy sand to sandy clay; massive; may have very abundant fine to medium, ferruginised gravel; pH 6.0-7.5

Note: Profiles with brown A horizons and a yellow B_2 horizon (Gn2.22) rarely occur in broad, flat drainage depressions.

VIOLET

Major attributes: A cobbly, hard setting, red-brown to dark, loamy sand to sandy clay with neutral reaction trend overlying rock or gravel by 300 mm depth

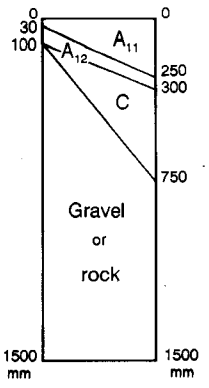
Principal profile forms: Uc1.23, Um1.21, Uf1.43, Um1.43, Uc1.21 **Great soil group:** Lithosol

Parent material: Devonian-Carboniferous acid volcanics and associated sedimentary rocks (and minor Pre-Devonian metamorphics)

Landform: Undulating low hills to gently undulating rises

Predominant vegetation: Narrow leaved ironbark ,tall to mid-high, or yapunyah, very tall to tall, open woodland to woodland

Surface features: Many to abundant medium gravel to stone; hard setting to firm



A_{11}: Dark to red-brown (5YR to 10YR 2/2 to 4/3), grey to red-brown (dry); loamy sand to sandy clay; massive to weak 5-10 mm subangular blocky; dry moderately weak to moderately firm; common to very abundant medium to coarse gravel; pH 6.0-7.0. Clear to diffuse to -

A_{12} (where present): Brown to red-brown (5YR to 7.5YR 2/3 to 4/4); loamy sand to sandy clay; dry moderately weak to moderately firm; common to very abundant medium to coarse gravel; pH 5.5-7.5. Clear to gradual to -

C (where present): Brown (7.5YR 4/3 to 5/4); loamy sand to sandy clay loam; many to very abundant fine to medium gravel; pH 6.0-7.0

WELL

Major attributes: A very fine self-mulching, brown to red-brown, cracking clay with acid reaction trend overlying strongly and coarsely mottled, acid, gleyed clay

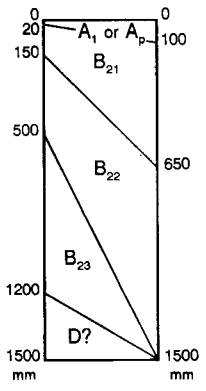
Principal profile forms: Ug5.38, Ug5.39. Ug5.34, Ug5.35, Ug5.3 **Great soil group:** Brown and red clay

Parent material: Cainozoic unconsolidated sediments

Landform: Gently undulating to level plains

Predominant vegetation: Gidgee and brigalow, tall to mid-high, open forest to woodland

Surface features: May have incipient normal gilgai (vertical interval .05-.15 m, horizontal interval 5-10 m); may have common, fine to coarse, quartz and ironstained gravel; cracking and self-mulching



A_1 or A_p: Brown to red-brown (7.5YR to 5YR 4/3, 4/4), grey-brown to red-brown (dry); medium to medium heavy clay; moderate to strong 2-10 mm subangular blocky parting to strong <2 mm granular; dry loose; may have few fine quartz and ironstained gravel; may have few carbonate nodules; pH 7.0-8.7. Clear to gradual to -

B_{21}: Brown to red-brown (7.5YR to 5YR 4/3 to 5/6); medium heavy clay; moderate to strong 10-50 mm blocky; dry very firm to moderately strong; may have few carbonate nodules; pH 7.0-8.7. Abrupt to gradual to -

B_{22}: As for B_{21}, except for strong lenticular structure and may have common gypsum crystals and common manganiferous nodules and veins. Abrupt to gradual to -

B_{23}: As for B_{22}, except may have common fine to coarse distinct gley, yellow and red to brown mottles; has no carbonate segregations and pH 4.5-6.5. Clear to diffuse to -

D?: Strongly and coarsely mottled, gley, red and yellow acid clay

Note: Occasionally, profiles have grey-brown (7.5 YR 5/3. 5/4) B horizons (Ug5.2) especially where adjacent to other grey clays.

WELL, FOOTSLOPE VARIANT

Major attributes: A coarse self-mulching, grey, brown and red, cracking clay with acid reaction trend overlying strongly and coarsely mottled, acid, gleyed clay

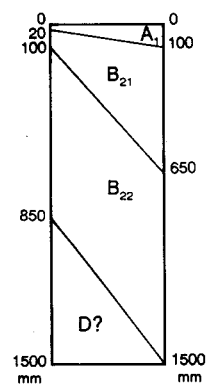
Principal profile forms: Ug5.24, Ug5.2, Ug5.35, Ug5.38, Ug5.3 **Great soil group:** Grey, brown and red clay

Parent material: Cainozoic unconsolidated sediments

Landform: Level to gently undulating plains

Predominant vegetation: Boree, tall to mid-high, woodland to open forest or gidgee and brigalow, tall to mid-high, open forest to woodland

Surface features: May have incipient normal gilgai (vertical interval .05-.10 m, horizontal interval 5-15 m); may have common, fine to medium, quartz and ironstained gravel; cracking and self-mulching



A_1: Grey to red (2.5Y to 2.5YR 4/2 to 4/6), grey to red (dry); medium to medium heavy clay; moderate to strong 2-20 mm subangular blocky parting to <2 to 5 mm granular; dry loose; may have few fine gravel; may have few carbonate nodules; pH 6.0-8.7. Clear to gradual to -

B_{21}: Grey to red (2.5Y to 2.5YR 4/1 to 4/6); medium heavy to heavy clay; moderate 10-50 mm angular blocky; dry very firm to very strong; may have few fine quartz and ironstained gravel; may have few carbonate nodules and soft segregations and/or common gypsum crystals and few manganiferous veins; pH 5.0-8.7. Abrupt to diffuse to -

B_{22}: As for B_{21}, except for strong lenticular structure; has no carbonate segregations and may have common gypsum crystals and common manganiferous veins. Abrupt to diffuse to -

D?: Strongly and coarsely mottled, gley, red and yellow acid clay

Note: In profiles with an alkaline B_{21} horizon the alkaline pH does not extend deeper than 1000 m depth.

WELL, SANDY SURFACE VARIANT

Major attributes: A flaking, red-brown to brown, mainly non-cracking clay with sand veneer and acid reaction trend overlying strongly and coarsely mottled, acid, gleyed clay by 900 mm depth

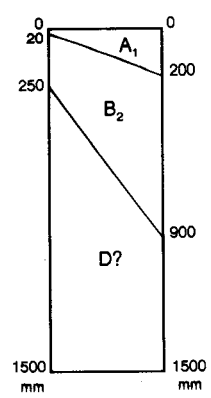
Principal profile forms: Uf6.31, Ug5.39, Ug5.35 **Great soil group:** No suitable group and red and brown clay

Parent material: Cainozoic unconsolidated sediments

Landform: Level plains

Predominant vegetation: Yapunyah, very tall to tall, open woodland to woodland or gidgee, tall to mid-high, woodland

Surface features: May have common, fine to medium, quartz and ironstained gravel; flaking, sand covered surface, may self-mulch upon disturbance



A_1: Red-brown to brown (5YR to 7.5YR 4/3, 4/4), brown to red-brown (dry); medium to medium heavy clay; moderate to strong 5-20 mm subangular blocky; dry moderately firm to loose; pH 6.0-9.0. Abrupt to gradual to -

B_2: Brown to red-brown (7.5YR to 5YR 4/3, 4/4); medium heavy to heavy clay; dry very firm to moderately strong; may have very few gypsum crystals and common carbonate nodules and soft segregations; pH 5.5-8.7. Clear to gradual to -

D?: Strongly and coarsely mottled, gley, red and yellow acid clay

WINDRADENE

Major attributes: A very fine self-mulching to firm, and occasionally cracking, dark to red, clay and clay loam with alkaline reaction trend overlying limestone by 400 mm depth

Principal profile forms: Uf6.31, Uf6.32, Uf6.33, Ug5.31, Ug5.36, Um6.41

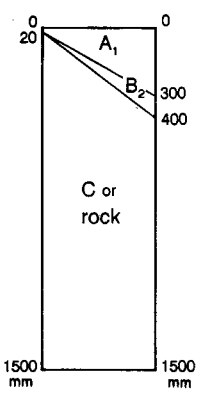
Great soil group: Rendzina - terra rossa soil

Parent material: Cainozoic soft and hard limestone

Landform: Level plains to gently undulating rises

Predominant vegetation: Dead finish, mid-high to tall, woodland to open woodland or gidgee and brigalow, tall to mid-high, open forest to woodland; or mountain coolibah or bloodwood, tall to mid-high, open woodland to woodland

Surface features: May have abundant limestone and other, fine gravel to cobble; may have 50% outcrop; firm to self-mulching (and occasionally) cracking



A_1: Dark to red (2.5YR to 10YR 2/1 to 4/4), dark to red (dry); clay loam to medium clay; weak to strong <2 mm granular and subangular blocky; dry loose to moderately firm; may have abundant fine to medium gravel; may have very many carbonate nodules; pH 8.5-9.0. Abrupt to gradual to -

B_2 (where present): Dark to red (2.5YR to 10YR 2/1 to 4/4); light to medium heavy clay; moderate to strong 2-20 mm subangular blocky; dry moderately firm to very firm; may have very abundant fine to medium gravel; may have very many carbonate nodules; pH 8.7-9.0

Notes: 1. A thin (50-200 mm) B3-BC horizon may occur between the B_2 and C horizon.

2. The profiles with clay loam surface textures directly overlie the C horizon or rock (Um6.41).

WINVIC

Major attributes: A gravelly, red to red-brown, clay loam, clay or duplex soil with neutral to alkaline reaction trend overlying unconsolidated quartz gravel by 500 mm depth

Principal profile forms: Um5.21, Uf6.31, Dr2.12

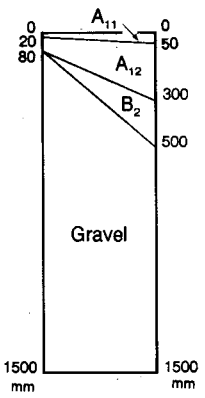
Great soil group: No suitable group

Parent material: Cainozoic sediments (gravel and soil material)

Landform: Gently undulating rises to level plains

Predominant vegetation: Dawson gum, tall to very tall, woodland to open woodland

Surface features: Few to very abundant, quartz and ironstained, fine to coarse gravel; hard setting



A_{11}: Brown to red (7.5YR to 2.5YR 3/3 to 4/4), brown to red-brown (dry); sandy clay loam, fine sandy to light clay; massive; dry moderately firm to very firm; pH 5.5-8.0. Abrupt to clear to -

EITHER A_{12}: Red to red-brown (2.5YR to 5YR 4/3, 4/4); clay loam to light clay; dry moderately firm to moderately strong; may have very abundant fine to coarse quartz gravel; pH 6.3-8.0. Clear to -

AND/OR B_2: Red to red-brown (2.5YR to 5YR 3/4 to 4/6); fine sandy clay to medium clay; may have abundant fine to coarse quartz gravel; pH 6.5-9.0

Notes: 1. The unconsolidated gravel below the soil are predominantly quartz and are probably derived from the Pre-Devonian Anakie metamorphics. A few carbonate nodules may occur in the gravel.

2. The clay loam profiles (Um5.21) do not have a B_2 horizon and overlie the quartz gravel by 300 mm depth.

YACKADOO

Major attributes: A gravelly, hard setting to firm, red-brown, clay and clay loam with neutral to alkaline reaction trend overlying soft and hard limestone with quartz gravel by 300 mm depth

Principal profile forms: Uf6.53, Um5.11, Uf6.31

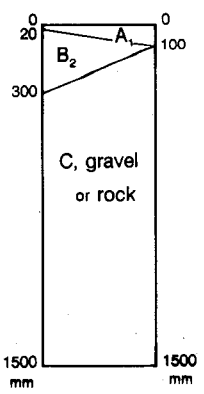
Great soil group: Terra rossa soil

Parent material: Cainozoic soft and hard limestone containing and interbedded with quartz gravel

Landform: Gently undulating plains

Predominant vegetation: Gidgee and brigalow, tall to mid-high open forest to woodland

Surface features: Very few to very abundant, quartz and limestone, fine gravel to cobble; may have 50% rock outcrop; hard setting to firm



A_1: Grey-brown to red-brown (5YR to 7.5YR 3/3 to 5/2), brown to red (dry); clay loam to light medium clay; massive to weak <2 mm subangular blocky; dry very weak to moderately firm; may have many fine to coarse quartz gravel; may have few carbonate nodules and soft segregations; pH 8.0-8.7. Abrupt to clear to -

B_2 (where present): Red-brown (5YR 4/3 to 4/6); clay loam to medium clay; massive to moderate structure; dry very weak to very firm; may have abundant fine to coarse quartz gravel; may have few carbonate nodules and soft segregations; pH 8.0-9.0

Note: Quartz gravel may occur in both the soft limestone (C horizon) and hard limestone rock.

APPENDIX III

MORPHOLOGICAL AND ANALYTICAL DATA FOR REPRESENTATIVE PROFILES

SOIL TYPE: **Apron**

SITE NO: S31 A.M.G. REFERENCE: 580 300 mE 7 530 400 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Gn3.13
SOIL TAXONOMY UNIT: Palexeralf
FAO UNESCO UNIT: Haplic Xerosol

SLOPE: 1 %
LANDFORM ELEMENT TYPE: Mid slope
LANDFORM PATTERN TYPE: Gently undulating rises

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few coarse pebbles, angular unspecified coarse fragments

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Mid-high woodland
DOMINANT SPECIES: Acacia harpophylla, Atalaya hemiglauca, Eremophila mitchellii, Canthium oleifolium, Carissa ovata, Apophyllum anomalum

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Hard setting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .20 m	Dark reddish brown (5YR3/3) moist; no mottles; clay loam,sandy; very few medium pebbles, angular quartz; weak 5-10mm subangular blocky; moderately moist; moderately weak; no segregations. Gradual to-
B2	.20 to .80 m	Dull reddish brown (5YR4/4) moist; no mottles; sandy clay; few medium pebbles, angular unspecified coarse fragments; dry; moderately firm; no segregations. Gradual to-
D1?	.80 to 1.25 m	Bright yellowish brown (10YR6/6) moist; no mottles; medium heavy clay; few small pebbles, subangular unspecified coarse fragments; dry; very firm; many coarse carbonate soft segregations, few fine manganiferous nodules. Gradual to-
D2?	1.25 to 1.50 m	Dull yellowish orange (10YR7/4) moist; no mottles; medium heavy clay; very few medium pebbles, angular sandstone, few small pebbles, subangular quartz; dry; very firm; few medium carbonate soft segregations, common fine manganiferous nodules.

Depth	1:5 Soil/Water pH	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S % @ 105C	C	Exch. Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C	Total Elements P	K	S % @ 80C	Moistures ADM	33*	1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Al	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
B 0.10	6.0	.03	.001																			
0.10	5.8	.03	.001	21	48	11	21	14	4.7	1.2	5.2	.42	.077	.791	.027	1.0		7	.65				
0.20	7.0	.07	.001													1.1							
0.30	8.2	.10	.001	24	45	13	21	12	8.3	0.8	.08	.65	.046	.824	.017	1.0		7	.53				
0.40	8.2	.09	.001													1.2							
0.50	8.3	.07	.001													1.9							
0.60	8.3	.08	.002	16	32	11	42	21	10	7.5	1.0	1.1	.030	1.03	.018	1.7		15	.63				
0.70	8.8	.22	.006													2.1							
0.80	9.0	.27	.009													2.0							
0.90	9.1	.35	.014	13	28	22	38	17	5.4	9.6	2.1	.72	.021	.833	.047	2.2		15	.67				
1.00	9.2	.42	.020													2.2							
1.10	9.2	.49	.026													2.1							
1.20	9.2	.57	.034	13	28	20	39	19	4.2	12	3.8	.65	.017	.845	.052	2.0							
1.50	9.0	.70	.049																			

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid	Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	Fe	DTPA-extr. Mn	Cu	Zn	B mg/kg @ 105C	Extractable SO4S	NO3N	NH4N mg/kg @ 105C	P Buff Cap	Equil ug/L @ 40C	Alternative Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C
B 0.10	1.2	.09	43	26	.69			35	28	1.1	1.4											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Aroa**

SITE NO: S34 A.M.G. REFERENCE: 588 000 mE 7 527 900 mN ZONE 55

GREAT SOIL GROUP: Brown clay
PRINCIPAL PROFILE FORM: Ug5.33
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Linear gilgai
VERTICAL INTERVAL: .15 m
HORIZONTAL INTERVAL: 10 m
COMPONENT OF MICRORELIEF SAMPLED: Elongate mound
SURFACE COARSE FRAGMENTS: Very few medium pebbles, subrounded quartz

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Eucalyptus orgadophila

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, surface crust

HORIZON	DEPTH	DESCRIPTION
A1	0 to .20 m	Brown (7.5YR4/3) moist, brown (7.5YR4/3) dry; no mottles; medium clay; no coarse fragments; strong <2mm granular; dry; loose; many medium carbonate nodules, few fine carbonate nodules. Clear to-
B21	.20 to .80 m	Brown (7.5YR4/3) moist; no mottles; medium clay; no coarse fragments; strong lenticular; dry; very firm; common medium carbonate nodules, few medium carbonate soft segregations. Diffuse to-
B22	.80 to 1.00 m	Dull reddish brown (5YR5/4) moist; no mottles; medium clay; no coarse fragments; strong lenticular; dry; very firm; common coarse carbonate soft segregations. Gradual to-
C	1.00 to 1.20 m	Very many carbonate soft segregations.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	33*	1500*	Disp.Ratio R1	R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres	@ 40C	dS/m @105C	%	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C			@ 40C		m.eq/100g @ 105C			@ 40C
B 0.10	8.8	.16	.001													8.4								
0.10	8.8	.13	.001	13	18	11	54	63	46	20	.26	.59	.021	.206	.027	8.6		27	.29					
0.20	8.8	.14	.001													9.1								
0.30	8.8	.14	.001	12	15	11	60	70	38	31	.24	.25	.014	.138	.017	8.6		31	.29					
0.40	8.8	.15	.001													6.8								
0.50	8.8	.14	.001													7.5								
0.60	8.9	.13	.001	11	14	10	59	67	32	37	.28	.25	.011	.130	.016	7.9		30	.26					
0.70	8.9	.14	.001													8.5								
0.80	8.9	.14	.001													8.5								
0.90	8.9	.13	.001	11	15	13	59	63	29	37	.32	.23	.012	.161	.017	8.3		29	.29					
1.00	9.1	.13	.001													7.1								
1.10	9.3	.11	.001													2.4								

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Bicarb.	HCl K	CaCl2 Extr K	P	Fe	DTPA-extr. Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K
metres	% @ 105C	% @ 105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C			mg/kg @ 105C				mg/kg @ 105C			@ 40C		m.eq/100g @ 105C				
B 0.10	1.4	.11	3	3	.29			7.6	3.3	0.5	0.2											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Aroa**

SITE NO: S35 A.M.G. REFERENCE: 588 000 mE 7 527 900 mN ZONE 55

GREAT SOIL GROUP: Black earth
PRINCIPAL PROFILE FORM: Ug5.12
SOIL TAXONOMY UNIT: Mollic Torrert
FAO UNESCO UNIT: Pellic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Linear gilgai
VERTICAL INTERVAL: .15 m
HORIZONTAL INTERVAL: 10 m
COMPONENT OF MICRORELIEF SAMPLED: Elongated depression
SURFACE COARSE FRAGMENTS: Very few medium pebbles, subrounded quartz

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Eucalyptus orgadophila

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, surface flake

HORIZON	DEPTH	DESCRIPTION
A1	0 to .03 m	Brownish black (7.5YR3/1) moist, brownish black (10YR3/1) dry; no mottles; medium heavy clay; no coarse fragments; strong 2-5mm granular; dry; loose; few medium carbonate nodules, very few fine carbonate nodules. Clear to-
B21	.03 to .30 m	Brownish black (7.5YR3/1) moist; no mottles; heavy clay; no coarse fragments; moderately moist; very firm; few medium carbonate nodules. Gradual to-
B22	.30 to 1.10 m	Brownish black (7.5YR3/1) moist; no mottles; heavy clay; no coarse fragments; strong lenticular; dry; moderately strong; few fine carbonate nodules, very few medium carbonate soft segregations. Gradual to-
C	1.10 to 1.20 m	Very many carbonate soft segregations, common carbonate nodules.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures		Disp.Ratio		Exch Exch ECEC		pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM 33*	1500*	R1	R2	Al	Acid	CaCl2
metres		dS/m	%			%			m.eq/100g					%			%				m.eq/100g	
	@ 40C		@105C			@ 105C			@ 105C					@ 80C			@ 105C	@ 40C			@ 105C	@ 40C
B 0.10	8.5	.18	.001													10.2						
0.10	8.7	.12	.001	8	10	6	71	88	65	22	.47	.71	.021	.245	.026	9.8	37	.29				
0.20	8.7	.13	.001													11.3						
0.30	8.7	.14	.001	4	9	8	75	91	64	26	.85	.44	.020	.199	.019	10.4	39	.28				
0.40	8.7	.15	.001													10.9						
0.50	8.8	.15	.001													11.5						
0.60	8.8	.14	.001	4	9	9	76	91	64	30	1.7	.41	.018	.199	.020	12.1	40	.31				
0.70	8.9	.16	.002													12.5						
0.80	8.8	.17	.003													10.4						
0.90	8.8	.19	.005	3	8	7	79	90	57	31	2.5	.42	.017	.199	.015	9.8	41	.38				
1.00	8.8	.26	.008													10.0						
1.10	8.9	.21	.010													9.7						
1.20	9.3	.16	.006	16	13	38	33	33	21	16	.93	.14	.009	.059	.018	4.2						

Depth	Org.C	Tot.N	Extr. P	HCl	CaCl2 Extr		DTPA-extr.					Extractable			P		Alternative Cations				
	(W&B)		Acid Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff	Equil	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg	meq%	mg/kg			mg/kg				mg/kg			Cap	ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C	@105C	@ 105C			@ 105C				@ 105C			@ 40C		@ 105C				
B 0.10	1.9	.15	28 6	.74																	

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Cattle**

SITE NO: S52 A.M.G. REFERENCE: 557 000 mE 7 560 800 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.25
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: .10 m
HORIZONTAL INTERVAL: 15 m
COMPONENT OF MICRORELIEF SAMPLED: Mound
SURFACE COARSE FRAGMENTS: Nil

DISTURBANCE OF SITE: Extensive clearing
VEGETATION
STRUCTURAL FORM: Tall open shrubland
DOMINANT SPECIES: Acacia harpophylla, Acacia cambagei, Terminalia oblongata

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Periodic cracking, self-mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .02 m	Greyish brown (7.5YR4/2) moist, greyish brown (7.5YR4/2) dry; no mottles; medium heavy clay; no coarse fragments; strong 5-10mm subangular blocky; dry; loose; no segregations. Clear to-
B21	.02 to .30 m	Greyish brown (5YR4/2) moist; no mottles; heavy clay; no coarse fragments; angular blocky; dry; moderately strong; very few fine carbonate nodules. Clear to-
B22	.30 to .90 m	Greyish brown (5YR4/2) moist; no mottles; heavy clay; no coarse fragments; strong lenticular; dry; moderately strong; very few fine carbonate nodules. Diffuse to-
B23	.90 to 1.70 m	Dull reddish brown (5YR4/3) moist; many medium faint gley mottles; heavy clay; no coarse fragments; strong lenticular; dry; very firm; common medium gypseous crystals, very few medium manganiferous cutans.

Depth	1:5 Soil/Water pH	1:5 Soil/Water EC	1:5 Soil/Water Cl	Particle Size CS	Particle Size FS	Particle Size S	Particle Size C	Exch. Cations CEC	Exch. Cations Ca	Exch. Cations Mg	Exch. Cations Na	Exch. Cations K	Total Elements P	Total Elements K	Total Elements S	Moistures ADM	Moistures 33*	Moistures 1500*	Disp.Ratio R1	Disp.Ratio R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres	@ 40C	dS/m @105C	% @105C	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C			@ 40C		m.eq/100g @ 105C			@ 40C
B 0.10	8.4	.10	.001	3	13	17	65	62	44	16	1.2	.55	.064	.081	.053	8.5		27	.67					
0.20	8.9	.13	.001																					
0.30	9.0	.15	.001	3	15	17	65	61	44	17	3.0	.13	.054	.038	.038	7.0		25	.37					
0.40	9.2	.16	.001																					
0.50	9.2	.21	.002																					
0.60	9.1	.34	.011	3	16	17	65	60	38	17	6.2	.13	.054	.036	.048	7.3		25	.52					
0.70	8.3	1.3	.045																					
0.80	7.9	2.8	.078																					
0.90	7.5	3.3	.124	3	16	17	65	57	34	18	9.8	.11	.043	.027	.965	8.1		25	.48					
1.00	6.5	3.1	.154																					
1.10	5.5	2.3	.186																					
1.20	5.1	1.7	.209	2	14	15	71	59	25	16	10	.11	.042	.028	.144	8.4								
1.30	4.7	2.4	.227																					
1.40	4.4	4.2	.221																					
1.50	4.3	3.7	.263																					

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Extr. P Bicarb.	HCl K	CaCl2 Extr K	CaCl2 Extr P	DTPA-extr. Fe	DTPA-extr. Mn	DTPA-extr. Cu	DTPA-extr. Zn	DTPA-extr. B	Extractable SO4S	Extractable NO3N	Extractable NH4N	P Buff Cap	P Equil	Alternative Cations CEC	Alternative Cations Ca	Alternative Cations Mg	Alternative Cations Na	Alternative Cations K
metres	% @ 105C	% @ 105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C		mg/kg @ 105C					mg/kg @ 105C			@ 40C	ug/L	m.eq/100g @ 105C				
B 0.10	0.8	.08	41	26	.25			18	18	1.2	.51											
0.10																		43	15	1.2	.51	
0.30																		42	16	2.8	.12	
0.60																		40	17	7.0	.10	
0.90																		58	18	12	.09	
1.20																		28	18	13	.07	

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol
Alternative cation method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Cheeseboro**

SITE NO: S55 A.M.G. REFERENCE: 597 800 mE 7 522 200 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Uf6.32
SOIL TAXONOMY UNIT: Mollisol
FAO UNESCO UNIT: Luvic Phaeozem

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Crest
LANDFORM PATTERN TYPE: Undulating rises

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Common stones, subangular basalt

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall open woodland
DOMINANT SPECIES: Eucalyptus orgadophila, Eucalyptus erythrophloia, Cassia brewsteri, Bothriochloa species, Panicum queenslandicum

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Surface flake

HORIZON	DEPTH	DESCRIPTION
A1	0 to .05 m	Black (7.5YR2/1) moist, brownish black (7.5YR2/2) dry; no mottles; light medium clay; few coarse pebbles, subangular basalt; moderate 5-10mm subangular blocky secondary, parting to moderate <2mm subangular blocky primary; dry; moderately firm; no segregations. Clear to-
B2	.05 to .20 m	Black (7.5YR2/1) moist; no mottles; medium heavy clay; few coarse pebbles, subangular basalt, very few cobbles, subangular basalt; moderately moist; very firm; no segregations.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P K S % @ 80C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 R2 @ 40C	Exch Exch ECEC Al Acid m.eq/100g @ 105C	pH CaCl2 @ 40C
B 0.10	7.2	.04	.001							
0.10	7.2	.06	.001	8 27 23 39	47 25 10 .13 3.2	.195 .808 .047	2.8 22	.51		
0.20	7.4	.05	.001				3.1			

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Extr. P Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P mg/kg	DTPA-extr. Fe Mn Cu Zn B mg/kg @ 105C	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Cap Equil ug/L @ 40C	Alternative Cations CEC Ca Mg Na K m.eq/100g @ 105C
B 0.10	2.4	.19	524	96	2.0			37 56 2.0 0.6			

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Cherwell**

SITE NO: S13 A.M.G. REFERENCE: 603 300 mE 7 541 500 mN ZONE 55

GREAT SOIL GROUP: Lithosol
PRINCIPAL PROFILE FORM: Uc1.24
SOIL TAXONOMY UNIT: Lithic Torriorthent
FAO UNESCO UNIT: Haplic Xerosol

SLOPE: 10 %
LANDFORM ELEMENT TYPE: Upper slope
LANDFORM PATTERN TYPE: Rolling low hills

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few cobbles, angular tabular sandstone

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Acacia shirleyi, Alphitonia excelsa, Aristida species

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Hard setting

HORIZON	DEPTH	DESCRIPTION
A11	0 to .25 m	Brownish black (7.5YR3/2) moist; no mottles; loamy coarse sand; few medium pebbles, subangular sandstone, very few coarse pebbles, angular tabular sandstone; massive; moist; very weak; no segregations. Clear to-
A12	.25 to .40 m	No mottles; coarse sand; many medium pebbles, subrounded sandstone, very few coarse pebbles, subangular sandstone; massive; moist; very weak; no segregations.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS % @ 105C	S % @ 105C	C % @ 105C	Exch. Cations CEC m.eq/100g @ 105C	Ca m.eq/100g @ 105C	Mg m.eq/100g @ 105C	Na m.eq/100g @ 105C	K m.eq/100g @ 105C	Total Elements P % @ 80C	K % @ 80C	S % @ 80C	Moistures ADM % @ 105C	33* %	1500* %	Disp.Ratio R1 @ 40C	R2 @ 40C	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
B 0.10	4.8	.03	.001																				
0.10	5.1	.02	.001	55	28	6	11	16	1.0	0.3	3.7	.08	.020	1.01	.022	0.2	5	.53					
0.20	4.9	.02	.001													0.8							

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P mg/kg @ 105C	DTPA-extr. Fe mg/kg @ 105C	Mn mg/kg @ 105C	Cu mg/kg @ 105C	Zn mg/kg @ 105C	B mg/kg @ 105C	Extractable SO4S mg/kg @ 105C	NO3N mg/kg @ 105C	NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L @ 40C	Alternative Cations CEC m.eq/100g @ 105C	Ca m.eq/100g @ 105C	Mg m.eq/100g @ 105C	Na m.eq/100g @ 105C	K m.eq/100g @ 105C
B 0.10	1.4	.09	5	2	.41			36	10	0.2	0.6											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 7
CEC method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Clarkei**

SITE NO: S40 A.M.G. REFERENCE: 596 800 mE 7 538 300 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Dr2.13
SOIL TAXONOMY UNIT: Lithic Haplargid
FAO UNESCO UNIT: Luvic Xerosol

SLOPE: 9 %
LANDFORM ELEMENT TYPE: Upper slope
LANDFORM PATTERN TYPE: Rolling low hills

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Common coarse pebbles, angular unspecified coarse fragments

DISTURBANCE OF SITE: Extensive clearing
VEGETATION
STRUCTURAL FORM: Tall isolated trees
DOMINANT SPECIES: Eucalyptus orgadophila, Brachychiton rupestre, Eucalyptus tessellaris, Eremophila mitchellii, Themeda australis

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Hard setting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .05 m	Brown (7.5YR4/4) moist; no mottles; loamy coarse sand; very few coarse pebbles, angular unspecified coarse fragments; massive; dry; very weak; very few fine carbonate soft segregations. Abrupt to-
B21	.05 to .30 m	Reddish brown (5YR4/6) moist; no mottles; sandy medium clay; few coarse pebbles, angular unspecified coarse fragments; moist; moderately firm; few fine manganiferous veins, few fine carbonate soft segregations. Clear to-
BC	.30 to .40 m	Orange (7.5YR6/6) moist; few fine distinct yellow mottles, very few fine distinct grey mottles; sandy clay; few medium pebbles, angular unspecified coarse fragments; moderately moist; moderately firm; few fine carbonate soft segregations.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @105C	Cl % @105C	Particle Size CS FS S % @ 105C	C	Exch. Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K	Total Elements P % @ 80C	K	S	Moistures ADM 33* 1500* % @ 105C		Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid	ECEC	pH CaCl2 @ 40C
B 0.05	7.6	.05	.001																		
0.05	7.2	.04	.001	22	62 4 11	8	5.1	1.2	.05	.36	.060	1.27	.021	0.3	5	.44					
0.20	7.7	.05	.001											0.9							
0.30	8.4	.13	.001	19	40 8 33	13	10	1.0	.05	.75	.239	2.41	.021	0.7	13	.74					

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	Fe	DTPA-extr. Mn mg/kg @ 105C	Cu	Zn	B	Extractable SO4S mg/kg @ 105C	NO3N	NH4N	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K
B 0.05	0.7	.07	260	6	.48		6	7	0.1	0.4											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Commissioner**

SITE NO: S12 A.M.G. REFERENCE: 597 500 mE 7 514 600 mN ZONE 55

GREAT SOIL GROUP: Lithosol
PRINCIPAL PROFILE FORM: Uc1.44
SOIL TAXONOMY UNIT: Lithic Torriorthent
FAO UNESCO UNIT: Haplic Xerosol

SLOPE: 18 %
LANDFORM ELEMENT TYPE: Mid slope
LANDFORM PATTERN TYPE: Rolling rises

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Many stones, angular material same as substrate material

DISTURBANCE OF SITE: No other disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Eucalyptus crebra, Eucalyptus erythrophloia, Atalaya hemiglauca, Eucalyptus species, Heteropogon contortus, Bothriochloa ewartiana

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Hard setting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .15 m	Black (7.5YR2/1) moist, brownish grey (7.5YR4/1) dry; no mottles; light sandy clay loam; many coarse pebbles, angular; massive; moderately moist; moderately weak; no segregations.

Depth metres	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS	FS	S	C % @ 105C	Exch. Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C	Total Elements P	K	S % @ 80C	Moistures ADM 33*	1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Exch ECEC Al	Acid m.eq/100g @ 105C	pH CaCl2 @ 40C
B 0.10	6.8	.05	.001																			
0.10	6.3	.03	.001	41	27	15	15	17	7.4	2.8	.25	.17	.027	3.03	.023	1.1	10	.40				

Depth metres	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe	Mn	Cu	Zn	B mg/kg @ 105C	Extractable SO4S	NO3N	NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C
B 0.10	2.3	.16	103	24	.94			18	15	0.3	2.1											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 7 CEC method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Diamond**

SITE NO: S10 A.M.G. REFERENCE: 559 400 mE 7 546 100 mN ZONE 55

GREAT SOIL GROUP: Red-brown clay
PRINCIPAL PROFILE FORM: Ug5.38
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded quartz

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall open tussock grassland

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Dull reddish brown (5YR4/3) moist; no mottles; medium heavy clay; no coarse fragments; moderately moist; moderately weak; few fine carbonate nodules, very few medium carbonate nodules. Abrupt to-
B21	.10 to .40 m	Dull reddish brown (5YR4/3) moist; no mottles; heavy clay; no coarse fragments; dry; very firm; few fine carbonate nodules, very few medium carbonate nodules. Abrupt to-
B22	.40 to .90 m	Dull reddish brown (5YR4/4) moist; no mottles; heavy clay; no coarse fragments; dry; moderately strong; common fine carbonate nodules, very few medium carbonate soft segregations. Gradual to-
B23	.90 to 1.25 m	Bright reddish brown (5YR5/6) moist, dull reddish brown (5YR4/4) moist; medium heavy clay; no coarse fragments; dry; very firm; very few fine carbonate nodules. Gradual to-
B24	1.25 to 1.60 m	Bright reddish brown (5YR5/6) moist; no mottles; medium clay; no coarse fragments; dry; moderately firm; many medium manganiferous veins, few medium gypseous crystals. Clear to-
B25	1.60 to 1.95 m	Dull reddish brown (5YR5/4) moist; few fine distinct red mottles; medium clay; no coarse fragments; dry; moderately firm; many coarse manganiferous veins, very few medium gypseous crystals.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C	Total Elements P	K % @ 80C	S	Moistures ADM	33*	1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Al	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
B 0.10	8.6	.16	.002																		7.7
0.10	8.5	.15	.001	04 09 14 71	76	48	21	2.0	1.2	.02	.38	.02	9.8	36		.57					7.7
0.20	9.0	.19	.001																		7.9
0.30	9.2	.22	.002	05 09 11 72	77	47	22	7.0	.71	.02	.34	.02	8.8	33		.39					8.0
0.40	9.2	.24	.002																		8.0
0.50	9.2	.29	.006																		8.0
0.60	9.1	.43	.032	04 10 13 72	77	42	24	11	.81	.02	.35	.02	6.9	33		.55					8.1
0.70	8.9	.74	.083																		8.1
0.80	8.8	1.1	.147																		8.1
0.90	8.7	1.4	.142	03 11 11 73	77	36	24	15	.69	.02	.35	.04	8.4	32		.60					8.2
1.00	8.7	1.6	.160																		8.2
1.10	8.6	1.9	.187																		8.2
1.20	8.1	3.6	.192	02 11 13 75	69	36	22	17	.57	.03	.29	.51	8.1	33		.50					8.0
1.30	8.0	4.4	.204																		7.8
1.40	8.0	4.5	.197																		7.8
1.50	8.0	4.6	.214	01 12 12 73	68	35	24	18	.47	.03	.24	.95	9.4	34		.46					7.8

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb.	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe	Mn	Cu	Zn	B mg/kg @ 105C	Extractable SO4S	NO3N	NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C
B 0.10	1.0	.09	18	7	1.6			14	7	1.6	0.4											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Diamond, footslope variant**

SITE NO: S6 A.M.G. REFERENCE: 558 800 mE 7 560 600 mN ZONE 55

GREAT SOIL GROUP: Red-brown clay
PRINCIPAL PROFILE FORM: Ug5.39
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 1 %
LANDFORM ELEMENT TYPE: Lower slope
LANDFORM PATTERN TYPE: Gently undulating rises

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded quartz

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Mid-high open tussock grassland

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Periodic cracking, self-mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .05 m	Dull reddish brown (5YR4/4) moist; no mottles; heavy clay; very few small pebbles, subrounded quartz; moderately moist; loose; no segregations. Clear to-
B21	.05 to 1.00 m	Dull reddish brown (5YR4/4) moist; no mottles; heavy clay; no coarse fragments; moderate 50-100mm subangular blocky secondary, parting to moderate 10-20mm lenticular primary; dry; very strong; very few fine carbonate nodules. Diffuse to-
D?	1.00 to 1.70 m	Olive grey (10Y6/2) moist, reddish brown (5YR4/6) moist; few fine prominent yellow mottles, few medium distinct red mottles; heavy clay; no coarse fragments; lenticular; moderately moist; very firm; few medium gypseous crystals, few fine manganiferous veins.

Depth	1:5 Soil/Water pH	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS % @ 105C	S	C	Exch. Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K	Total Elements P % @ 80C	K	S	Moistures ADM 33* % @ 105C	1500*	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid	ECEC	pH CaCl2 @ 40C
B 0.10	8.3	.10	.003																		7.1
0.10	8.4	.09	.002	04	11	11 78	77	45	22	3.8	.11	.02	.01	.05	7.6	26	.35				7.2
0.20	8.6	.12	.004																		7.4
0.30	8.8	.13	.002	04	10	09 79	78	45	22	6.4	.08	.02	.01	.04	8.2	27	.44				7.5
0.40	8.9	.15	.005																		7.7
0.50	8.9	.24	.016																		7.8
0.60	8.7	.44	.046	02	10	09 79	78	41	23	9.9	.05				8.4	28	.53				7.9
0.70	8.5	.76	.089																		7.9
0.80	8.3	1.2	.142																		7.8
0.90	8.2	1.4	.181	02	08	10 79	77	40	23	13	.06				7.5	29	.51				7.8
1.00	8.1	1.6	.203																		7.8
1.10	7.8	2.2	.213																		7.6
1.20	7.5	3.9	.242	01	08	06 82	76	42	23	14	.06				7.2	32	.51				7.5
1.30	7.4	4.0	.253																		7.4
1.40	7.2	4.0	.292																		7.2
1.50	7.0	5.0	.319	01	04	08 92	78	42	23	14	.05				8.9	36	.53				7.0

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb.	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S mg/kg @ 105C	NO3N	NH4N	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K
B 0.10	0.5	.06	3	4	.12			16	15	1.2	0.4											
0.10																			44	20	4.2	.12
0.30																			48	23	7.5	.09
0.60																			42	21	11	.05
0.90																			39	22	16	.05
1.20																			56	21	18	.06
1.50																			73	23	20	.65

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Dickson**

SITE NO: S20 A.M.G. REFERENCE: 564 800 mE 7 517 300 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Uf6.31
SOIL TAXONOMY UNIT: Torrox
FAO UNESCO UNIT: Orthic Ferralsol

SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Mid slope
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded unspecified coarse fragments

DISTURBANCE OF SITE: Complete clearing
VEGETATION
STRUCTURAL FORM: Mid-high tussock grassland
DOMINANT SPECIES: Cenchrus ciliaris

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching to firm

HORIZON	DEPTH	DESCRIPTION
A1	0 to .01 m	Dull reddish brown (2.5YR4/4) moist, bright brown (2.5YR5/6) dry; no mottles; light clay; very few small pebbles, subrounded quartz; strong <2mm subangular blocky; dry; loose; no segregations. Clear to-
AB	.01 to .05 m	Dull reddish brown (2.5YR4/4) moist; no mottles; light medium clay; no coarse fragments; dry; very firm; no segregations. Gradual to-
B21	.05 to .70 m	Reddish brown (2.5YR4/6) moist; no mottles; light medium clay; no coarse fragments; moderate structure; dry; very firm; no segregations. Gradual to-
B3	.70 to 1.20 m	Reddish brown (2.5YR4/6) moist; no mottles; light medium clay; common medium pebbles, subangular basalt; dry; very firm; no segregations. Gradual to-
C	1.20 to 1.30 m	Very abundant fragments, basalt.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures		Disp.Ratio		Exch Exch ECEC		pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM 33*	1500*	R1	R2	Al	Acid	CaCl2
metres		dS/m	%		%				m.eq/100g					%			%				m.eq/100g	
	@ 40C		@105C		@ 105C				@ 105C					@ 80C			@ 105C	@ 40C			@ 105C	@ 40C
B 0.10	7.5	.24	.002					28	22	2.9	.06	3.0										
0.10	7.5	.12	.001	4	9	14	71	19	15	2.5	.02	1.8	.169	.273	.034	2.4	20	.29				
0.20	7.4	.08	.001																			
0.30	7.2	.06	.001	4	8	12	75	14	11	2.6	.02	.89	.120	.185	.017	2.6	21	.19				
0.40	7.0	.08	.001																			
0.50	6.1	.11	.001																			
0.60	5.5	.10	.001	4	10	11	75	12	8.3	3.3	.02	.48	.109	.145	.028	2.4	21	.15				
0.70	5.3	.10	.001																			
0.80	5.2	.10	.001																			
0.90	5.2	.10	.001	6	11	12	69	12	7.8	4.5	.02	.40	.095	.126	.026	2.7	22	.15				
1.00	5.2	.10	.001																			
1.10	5.2	.10	.001																			
1.20	5.3	.09	.001	14	17	12	56	12	7.4	4.4	.02	.28	.090	.088	.020	2.2						

Depth	Org.C	Tot.N	Extr. P	HCl	CaCl2 Extr		DTPA-extr.					Extractable			P		Alternative Cations				
	(W&B)		Acid Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff	Equil	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg	meq%	mg/kg			mg/kg					mg/kg		Cap	ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C	@105C	@ 105C			@ 105C					@ 105C		@ 40C		@ 105C				
B 0.10	2.8	.25	102	2.4			22	83	4.4	5.0											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 7 CEC method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Eleanor**

SITE NO: S14 A.M.G. REFERENCE: 561 400 mE 7 556 800 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.25
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded quartz

DISTURBANCE OF SITE: Rainfed cultivation
VEGETATION

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Recently cultivated

HORIZON	DEPTH	DESCRIPTION
AP	0 to .15 m	Greyish yellow-brown (10YR4/2) moist; no mottles; heavy clay; no coarse fragments; moist; moderately firm; few medium carbonate nodules, very few medium carbonate nodules. Clear to-
B21	.15 to .45 m	Greyish yellow-brown (10YR4/2) moist; no mottles; heavy clay; no coarse fragments; moist; moderately firm; few medium carbonate nodules. Gradual to-
B22	.45 to 1.35 m	Greyish yellow-brown (10YR4/2) moist; no mottles; heavy clay; no coarse fragments; moderately moist; very firm; few medium carbonate nodules, very few fine manganiferous nodules. Gradual to-
B23	1.35 to 1.60 m	Brown (7.5YR4/3) moist; few medium distinct grey mottles; medium clay; no coarse fragments; dry; very firm; common medium manganiferous veins, few coarse gypseous crystals. Clear to-
B24	1.60 to 1.85 m	Bright reddish brown (5YR5/6) and dull reddish brown (5YR5/4) moist; medium distinct grey mottles; medium clay; no coarse fragments; dry; very firm; common coarse gypseous crystals, common medium manganiferous veins, few coarse carbonate soft segregations.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures		Disp.Ratio		Exch Exch ECEC		pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM 33*	1500*	R1	R2	Al	Acid	CaCl2
metres		dS/m	%			%			m.eq/100g					%			%				m.eq/100g	
	@ 40C		@105C			@ 105C				@ 105C				@ 80C			@ 105C	@ 40C			@ 105C	@ 40C
B 0.10	8.3	.23	.002					67	55	16	1.6	.72										
0.10	8.4	.15	.001	2	15	14	67	68	55	16	1.6	.64	.02	.09	.02	6.9	26	.32				
0.20	8.7	.18	.001																			
0.30	8.9	.20	.001	3	16	13	68	67	51	18	4.3	.19	.02	.07	.02	6.7	27	.39				
0.40	9.0	.20	.001																			
0.50	9.1	.22	.001																			
0.60	9.1	.24	.001	3	15	12	71	68	46	18	8.0	.22	.02	.07	.04	7.7	28	.48				
0.70	9.1	.27	.003																			
0.80	9.1	.29	.011																			
0.90	9.0	.40	.026	2	15	15	70	73	42	18	10	.22	.02	.08	.03	6.9	29	.53				
1.00	8.9	.62	.053																			
1.10	8.7	.89	.097																			
1.20	8.6	1.1	.126	2	14	15	69	71	37	18	13	.22	.02	.08	.05	7.9						
1.30	8.6	1.3	.138																			
1.40	8.2	2.0	.142																			
1.50	7.7	4.0	.144					67	38	18	13	.19										
1.80	7.7	4.3	.167	5	4	39	49	68	44	22	13	.21	.04	.07	6.22	10.3						

Depth	Org.C	Tot.N	Extr. P		HCl	CaCl2 Extr		DTPA-extr.					Extractable			P		Alternative Cations				
	(W&B)		Acid	Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff	Equil	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg		meq%	mg/kg			mg/kg				mg/kg			Cap	ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C		@105C	@ 105C			@ 105C				@ 105C			@ 40C		@ 105C				
B 0.10	0.7	.07		12	.63			19	15	1.2	0.3											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Eleanor**

SITE NO: S15 A.M.G. REFERENCE: 561 300 mE 7 557 400 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.25
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded unspecified coarse fragments

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall open tussock grassland
DOMINANT SPECIES: Sporobolus species

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .05 m	Greyish yellow-brown (10YR4/2) moist, greyish yellow-brown (10YR4/2) dry; no mottles; medium heavy clay; no coarse fragments; strong 2-5mm subangular blocky; dry; loose; common medium carbonate nodules. Gradual to-
B21	.05 to .30 m	Greyish yellow-brown (10YR4/2) moist; no mottles; medium heavy clay; no coarse fragments; dry; very firm; few fine carbonate nodules. Clear to-
B22	.30 to 1.30 m	Greyish yellow-brown (10YR4/2) moist; no mottles; heavy clay; no coarse fragments; lenticular; dry; moderately strong; few medium carbonate nodules, very few coarse carbonate nodules. Diffuse to-
B23	1.30 to 1.70 m	Bright reddish brown (5YR5/6) moist, brown (7.5YR4/3) moist; medium heavy clay; no coarse fragments; dry; very firm; common very coarse gypseous crystals, common medium manganiferous veins.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures		Disp.Ratio		Exch Al	Exch Acid	ECEC	pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM	33* 1500*	R1	R2				CaCl2
metres		dS/m	%			%			m.eq/100g					%			%				m.eq/100g		
	@ 40C		@105C			@ 105C			@ 105C					@ 80C			@ 105C	@ 40C			@ 105C		@ 40C
B 0.10	8.4	.11	.001																				7.4
0.10	8.1	.12	.001	7	12	14	65	66	53	15	1.1	.54	.02	.12	.04	5.3	28	.44					7.2
0.20	8.8	.12	.001																				7.5
0.30	8.9	.14	.001	6	13	15	67	67	51	17	4.9	.14	.02	.10	.04	6.0	26	.30					7.6
0.40	9.0	.17	.001																				7.7
0.50	9.1	.21	.001																				7.7
0.60	9.0	.23	.002	6	15	13	69	68	45	18	8.4	.14	.02	.12	.05	5.5	27	.49					7.7
0.70	9.1	.25	.004																				7.7
0.80	9.1	.32	.014																				7.7
0.90	9.0	.42	.029	8	13	15	68	67	43	18	12	.14	.01	.07	.03	6.3	27	.56					7.8
1.00	8.8	.55	.046																				7.8
1.10	8.5	1.3	.070																				7.8
1.20	8.4	1.6	.114	4	14	13	69	67	40	18	13	.17	.02	.08	.14	6.2	27	.49					7.8
1.30	7.9	4.0	.106																				7.6
1.40	7.9	4.3	.137																				7.7
1.50	7.8	4.5	.164	8	11	20	62	61	38	17	13	.15	.03	.07	4.75	5.5	30	.32					7.6

Depth	Org.C	Tot.N	Extr. P	HCl	CaCl2 Extr		DTPA-extr.					Extractable			P	Alternative Cations				
	(W&B)		Acid Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff Cap	Equil ug/L	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg	meq%	mg/kg		mg/kg					mg/kg					m.eq/100g				
	@ 105C	@ 105C	@ 105C	@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	0.8	.07	17	.43			15	6	1.2	0.4											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Eleanor, mottled phase**

SITE NO: S27 A.M.G. REFERENCE: 570 800 mE 7 553 600 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.24
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Pellic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded quartz

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall tussock grassland
DOMINANT SPECIES: Panicum species, Aristida species

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Periodic cracking, self-mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .03 m	Brownish grey (10YR4/1) moist, brownish grey (10YR4/1) dry; no mottles; medium heavy clay; no coarse fragments; strong 2-5mm granular; dry; loose; very few medium carbonate nodules. Clear to-
B21	.03 to .25 m	Brownish grey (7.5YR4/1) moist; no mottles; heavy clay; no coarse fragments; dry; moderately strong; very few fine carbonate nodules. Gradual to-
B22	.25 to 1.20 m	Brownish grey (7.5YR4/1) moist; no mottles; heavy clay; very few small pebbles, subrounded quartz; strong lenticular; dry; moderately strong; few fine carbonate nodules, very few medium carbonate soft segregations. Diffuse to-
B23	1.20 to 1.60 m	Greyish yellow-brown (10YR5/2) moist; no mottles; heavy clay; no coarse fragments; dry; very firm; common medium gypseous crystals, few fine manganiferous veins. Diffuse to-
D?	1.60 to 1.85 m	Greenish grey (10GY5/1) moist; common medium prominent red mottles, few medium distinct brown mottles; heavy clay; no coarse fragments; strong lenticular; dry; very firm; few fine gypseous crystals.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS	FS	S	C (%, @ 105C)	Exch. Cations CEC	Ca	Mg	Na	K (m.eq/100g, @ 105C)	Total Elements P	K	S (%, @ 80C)	Moistures ADM 33*	1500* (%, @ 105C)	Disp.Ratio R1	R2 (@ 40C)	Exch Al	Exch Acid (m.eq/100g, @ 105C)	ECEC	pH CaCl2 @ 40C
B 0.10	8.7	.08	.001																				
0.10	8.5	.08	.002	9	17	14	57	62	40	18	3.1	.23	.009	.045	.026	6.8	23	.60					
0.20	8.7	.10	.003																				
0.30	8.9	.12	.004	9	15	13	60	62	38	19	5.4	.14	.007	.036	.014	7.4	24	.54					
0.40	9.0	.14	.008																				
0.50	8.8	.27	.026																				
0.60	8.7	.43	.049	10	15	13	59	61	35	19	9.1	.15	.007	.043	.015	7.5	24	.67					
0.70	8.5	.66	.082																				
0.80	8.4	.95	.128																				
0.90	8.6	1.2	.153	8	16	15	62	62	32	20	13	.18	.007	.053	.031	7.7	25	.73					
1.00	8.5	1.5	.177																				
1.10	8.4	1.6	.200																				
1.20	8.3	1.7	.223	6	14	17	62	63	30	20	15	.23	.006	.079	.037	7.6							
1.30	7.6	4.0	.247																				
1.40	7.4	4.5	.263																				
1.50	7.4	4.5	.259																				
1.60	7.3	3.4	.242	10	18	14	57	51	25	17	12	.11	.009	.030	.401	6.9							

Depth	Org.C (W&B) @ 105C	Tot.N @ 105C	Extr. P Acid	Extr. P Bicarb. (mg/kg @ 105C)	HCl K meq%@105C	CaCl2 Extr K	CaCl2 Extr P (mg/kg @ 105C)	DTPA-extr. Fe	Mn	Cu	Zn	B (mg/kg @ 105C)	Extractable SO4S	NO3N	NH4N (mg/kg @ 105C)	P Buff Cap @ 40C	P Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K (m.eq/100g @ 105C)
B 0.10	0.6	.04		5	.19			16	18	0.9	0.1											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Falkner**

SITE NO: S16 A.M.G. REFERENCE: 551 000 mE 7 523 000 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.22P
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Few medium pebbles, subrounded quartz

DISTURBANCE OF SITE: Rainfed cultivation

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, surface flake

HORIZON	DEPTH	DESCRIPTION
AP	0 to .20 m	Greyish yellow-brown (10YR4/2) moist; no mottles; heavy clay; very few small pebbles, subrounded quartz; moist; moderately firm; very few coarse carbonate nodules. Gradual to-
B21	.20 to .70 m	Greyish yellow-brown (10YR4/2) moist; no mottles; heavy clay; very few small pebbles, subrounded quartz; strong lenticular; dry; very firm; very few medium carbonate nodules. Clear to-
B3	.70 to .85 m	Greyish brown (7.5YR4/2) moist; no mottles; medium heavy clay; common small pebbles, basalt; dry; very firm; common medium carbonate nodules. Gradual to-
C	.85 to 1.60 m	Fragments, basalt.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	33*	1500*	Disp.Ratio R1	R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres	@ 40C	dS/m @105C	%	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C			@ 40C		m.eq/100g @ 105C			@ 40C
B 0.10	7.8	.09	.001										.022	.092	.017	7.2								
0.10	7.9	.09	.001	1	17	13	71	69	53	20	.35	.84				7.2		26	.38					
0.20	8.0	.11	.001													8.3								
0.30	8.2	.06	.001	1	16	9	73	78	52	20	.39	.19	.017	.060	.013	7.3		27	.35					
0.40	8.3	.06	.001													8.5								
0.50	8.4	.07	.001													8.7								
0.60	8.5	.07	.001	1	16	12	72	78	51	22	.57	.19	.015	.063	.017	9.0		27	.37					
0.70	8.5	.10	.001													7.3								
0.80	8.6	.15	.001													7.9								

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb.	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe	Mn	Cu	Zn	B mg/kg @ 105C	Extractable SO4S	NO3N	NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C
B 0.10	0.8	.06	16	9	.68			19	13	1.1	0.4											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Fletcher**

SITE NO: S36 A.M.G. REFERENCE: 571 800 mE 7 545 200 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Uf6.31
SOIL TAXONOMY UNIT: Calciorthid
FAO UNESCO UNIT: Calcic Xerosol

SLOPE: 2 %
LANDFORM ELEMENT TYPE: Lower slope
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded quartz

DISTURBANCE OF SITE: Complete clearing
VEGETATION
STRUCTURAL FORM: Tall tussock grassland
DOMINANT SPECIES: Cenchrus ciliaris

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Hard setting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .05 m	Dark reddish brown (5YR3/3) moist; no mottles; sandy medium heavy clay; no coarse fragments; moist; moderately firm; no segregations. Clear to-
B21	.05 to .35 m	Dark reddish brown (5YR3/4) moist; no mottles; sandy heavy clay; very few small pebbles, subangular unspecified coarse fragments; moist; moderately firm; very few medium carbonate nodules. Gradual to-
B22	.35 to 1.00 m	Dull reddish brown (5YR4/4) moist; few fine distinct dark mottles; heavy clay; few small pebbles, subangular unspecified coarse fragments; moderately moist; very firm; common coarse carbonate soft segregations, very few coarse carbonate nodules. Clear to-
B23	1.00 to 1.25 m	Reddish brown (5YR4/6) moist, brown (7.5YR4/6) moist; no mottles; sandy medium clay; few small pebbles, subangular unspecified coarse fragments; dry; very firm; common carbonate soft segregations, few coarse carbonate nodules. Clear to-
B24	1.25 to 1.50 m	Brown (7.5YR4/4) moist; no mottles; sandy medium clay; no coarse fragments; dry; moderately firm; many carbonate soft segregations, few coarse carbonate nodules.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures		Disp.Ratio		Exch Exch ECEC		pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM 33*	1500*	R1	R2	Al	Acid	CaCl2
metres		dS/m	%			%			m.eq/100g					%			%				m.eq/100g	
	@ 40C	@105C		@ 105C				@ 105C					@ 80C			@ 105C		@ 40C		@ 105C		@ 40C
B 0.10	7.5	.04	.001																			
0.10	7.4	.03	.001	29	31	7	33	29	16	9.8	.10	.41	.030	.255	.022	3.0	13	.41				
0.20	7.5	.03	.001													3.7						
0.30	7.7	.06	.001	27	30	8	37	34	19	11	.20	.21	.021	.177	.018	3.9		.40				
0.40	8.7	.11	.001													3.8						
0.50	8.8	.11	.001													3.7						
0.60	8.9	.12	.001	21	30	16	32	30	14	14	.39	.17	.018	.181	.021	2.6	14	.49				
0.70	8.9	.13	.001													2.7						
0.80	8.9	.14	.001													2.8						
0.90	9.1	.15	.002	22	35	12	30	27	10	16	.74	.22	.019	.259	.018	3.1	13	.51				
1.00	9.1	.16	.003													3.0						
1.10	9.1	.15	.002													2.8						
1.20	9.2	.17	.003	25	38	11	25	23	7.1	16	.95	.17	.021	.306	.019	2.0						
1.30	9.2	.20	.005													1.9						
1.40	9.2	.23	.008													1.7						
1.50	9.2	.25	.012																			

Depth	Org.C	Tot.N	Extr. P		HCl	CaCl2 Extr		DTPA-extr.					Extractable			P		Alternative Cations				
	(W&B)		Acid	Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff	Equil	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg		meq%	mg/kg			mg/kg				mg/kg			Cap	ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C		@105C	@ 105C			@ 105C				@ 105C			@ 40C		@ 105C				
B 0.10	0.8	.07	9	4	.45			11	13	0.7	0.2											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Heyford**

SITE NO: S33 A.M.G. REFERENCE: 594 000 mE 7 536 800 mN ZONE 55

GREAT SOIL GROUP: Solodized solonetz/solodic soil
PRINCIPAL PROFILE FORM: Dy3.43
SOIL TAXONOMY UNIT: Natrargid
FAO UNESCO UNIT: Orthic Solonetz

SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Gently undulating plains

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded unspecified coarse fragments

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Eucalyptus populnea, Cassia brewsteri

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Hard setting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Brown (7.5YR4/3) moist, dull brown (7.5YR6/3) dry; no mottles; sandy loam; no coarse fragments; massive; dry; moderately firm; no segregations. Clear to-
A2cb	.10 to .25 m	Dull orange (7.5YR6/4) moist, dull orange (7.5YR7/3) dry; no mottles; sandy loam; no coarse fragments; massive; dry; moderately firm; no segregations. Abrupt to-
B21	.25 to .50 m	Orange (7.5YR6/6) moist, greyish brown (7.5YR6/2) moist; medium clay; few medium pebbles, subangular sandstone; dry; moderately strong; common medium manganiferous veins. Clear to-
B22	.50 to 1.10 m	Bright brown (7.5YR5/6) moist; few fine prominent red mottles, few fine distinct grey mottles; medium clay; no coarse fragments; dry; moderately strong; common coarse carbonate soft segregations, few coarse manganiferous veins. Clear to-
BC	1.10 to 1.30 m	Orange (7.5YR6/6) moist; common coarse distinct gley mottles; abundant fragments, sandstone; no segregations.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @105C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P % @ 80C	K % @ 105C	S % @ 105C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Exch ECEC Al Acid m.eq/100g @ 105C	pH CaCl2 @ 40C
B 0.10	6.8	.02	.001					0.7					
0.10	7.5	.02	.001	16 70 4 12	6 4.1 1.6 .05 .53	.026	.839	.011	0.7	3	.63		
0.20	7.2	.02	.001						0.4				
0.25	7.4	.03	.002	20 67 6 10	4 2.4 1.0 .05 .34	.017	.833	.026	0.4	2	.74		
0.40	7.0	.41	.061						2.2				
0.50	8.0	.44	.064						2.3				
0.60	9.1	.55	.055	8 48 4 42	14 5.8 5.7 2.5 .68	.022	1.73	.040	1.8	15	.85		
0.70	9.2	.57	.056						1.9				
0.80	9.3	.59	.058						1.9				
0.90	9.3	.61	.061	14 43 7 37	13 5.2 8.1 2.6 .50	.020	1.85	.046	1.8	13	.88		
1.00	9.4	.62	.061						1.9				
1.10	9.4	.63	.063						1.6				
1.20	9.4	.66	.069	10 44 11 37	13 4.4 8.3 3.2 .45	.032	2.43	.023	1.7				
1.30	9.3	.65	.068						1.8				
1.35	9.4	.68	.073						2.0				

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb.	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	Fe	DTPA-extr. Mn mg/kg @ 105C	Cu	Zn	B	Extractable SO4S NO3N mg/kg @ 105C	NH4N	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K
B 0.10	0.6	.03	7	3	.40			14	13	0.4	0.6										

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Holding**

SITE NO: S18 A.M.G. REFERENCE: 567 400 mE 7 561 900 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Uf6.33
SOIL TAXONOMY UNIT: Calciorthid
FAO UNESCO UNIT: Calcic Xerosol

SLOPE: 1 %
LANDFORM ELEMENT TYPE: Mid slope
LANDFORM PATTERN TYPE: Gently undulating rises

TYPE OF MICRORELIEF: Lattice gilgai
VERTICAL INTERVAL: .20 m
HORIZONTAL INTERVAL: 5 m
COMPONENT OF MICRORELIEF SAMPLED: Elongate mound
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded unspecified coarse fragments

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Mid-high woodland
DOMINANT SPECIES: Eucalyptus terminalis, Eucalyptus papuana, Dichanthium sericeum

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching

HORIZON	DEPTH	DESCRIPTION
A11	0 to .03 m	Dull reddish brown (5YR4/4) moist, dull reddish brown (5YR5/4) dry; no mottles; medium clay; no coarse fragments; strong <2mm subangular blocky; dry; loose; many medium carbonate nodules. Gradual to-
B21	.03 to .35 m	Dull reddish brown (5YR4/4) moist; no mottles; medium clay; no coarse fragments; dry; moderately firm; common medium carbonate nodules. Gradual to-
B22	.35 to 1.40 m	Dull reddish brown (5YR5/4) moist; no mottles; medium heavy clay; no coarse fragments; strong lenticular; dry; very firm; many medium carbonate nodules, very few fine manganiferous veins. Gradual to-
D1	1.40 to 1.55 m	Light clay; very abundant small pebbles, subrounded unspecified coarse fragments; dry; moderately weak; many fine carbonate nodules, few fine manganiferous nodules. Clear to-
D2	1.55 to 1.70 m	Dull reddish brown (5YR5/4) moist; no mottles; coarse sandy medium clay; no coarse fragments; dry; moderately firm; common coarse carbonate soft segregations, very few medium manganiferous veins. Clear to-
D3	1.70 to 1.80 m	Light medium clay; very abundant small pebbles, subrounded unspecified coarse fragments, very few medium pebbles, subrounded quartz; dry; moderately weak; many fine carbonate nodules, very few fine manganiferous nodules.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P K S % @ 80C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 R2 @ 40C	Exch Exch ECEC Al Acid m.eq/100g @ 105C	pH CaCl2 @ 40C
B 0.10	8.4	.20	.001		57 52 9.3 0.5 0.6					
0.10	8.4	.15	.001	12 19 12 53	58 52 10 0.3 0.1	.03 .04 .06	6.0 23	.45		
0.20	8.5	.16	.001							
0.30	8.6	.15	.001	11 18 11 57	63 49 15 .91 .10	.03 .04 .03	6.8 24	.21		
0.40	8.7	.16	.001							
0.50	8.8	.17	.001							
0.60	8.9	.18	.001	12 18 11 58	61 44 16 2.8 .10	.027 .035 .028	7.0 24	.28		
0.70	9.0	.20	.001							
0.80	9.0	.20	.001							
0.90	9.0	.22	.001	12 18 12 56	57 42 15 3.9 .13	.030 .038 .021	5.7 24	.28		
1.00	9.1	.23	.001							
1.10	9.1	.24	.001							
1.20	9.1	.24	.001	11 19 12 58	61 43 16 5.1 .18	.035 .036 .025	7.5			
1.30	9.1	.25	.001							
1.40	9.2	.25	.002							
1.50	9.3	.22	.003	41 22 5 27	38 24 9.9 3.8 .09	.105 .068 .078	5.0			

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe Mn Cu Zn B mg/kg @ 105C	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Equil Cap ug/L @ 40C	Alternative Cations CEC Ca Mg Na K m.eq/100g @ 105C
B 0.10	1.4	.12	24	.59			13 12 0.7 0.3			
1.00		.03					8 5 0.6 .05			
1.10		.03					9 4 0.5 .05			

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Holding**

SITE NO: S19 A.M.G. REFERENCE: 567 400 mE 7 561 900 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.2
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 1 %
LANDFORM ELEMENT TYPE: Mid slope
LANDFORM PATTERN TYPE: Gently undulating rises

TYPE OF MICRORELIEF: Lattice gilgai
VERTICAL INTERVAL: .20 m
HORIZONTAL INTERVAL: 5 m
COMPONENT OF MICRORELIEF SAMPLED: Elongated depression
SURFACE COARSE FRAGMENTS: Nil

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Mid-high woodland
DOMINANT SPECIES: Eucalyptus terminalis, Eucalyptus papuana, Dichanthium sericeum

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Periodic cracking, self-mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .02 m	Greyish brown (7.5YR4/2) moist, greyish brown (7.5YR4/2) dry; no mottles; medium clay; no coarse fragments; strong 2-5mm granular; dry; loose; few medium carbonate nodules, very few coarse carbonate nodules. Gradual to-
B21	.02 to .30 m	Greyish brown (7.5YR4/2) moist; no mottles; medium clay; no coarse fragments; dry; very firm; few medium carbonate nodules. Gradual to-
B22	.30 to 1.30 m	Greyish brown (7.5YR4/2) moist; no mottles; medium heavy clay; very few small pebbles, subangular quartz, very few small pebbles, subrounded unspecified coarse fragments; strong lenticular; dry; very firm; few medium carbonate nodules, very few coarse carbonate nodules. Diffuse to-
D	1.30 to 1.80 m	Dull reddish brown (5YR5/4) moist; no mottles; light medium clay; very abundant small pebbles, subrounded unspecified coarse fragments; dry; very firm; many fine carbonate nodules, few fine manganiferous veins.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures			Disp.Ratio		Exch Exch ECEC		pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM 33*	1500*		R1	R2	Al	Acid	CaCl2
metres		dS/m	%		%				m.eq/100g					%			%					m.eq/100g	
	@ 40C		@105C		@ 105C				@ 105C					@ 80C			@ 105C		@ 40C			@ 105C		@ 40C
B 0.10	8.3	.13	.001					69	63	9.3	.48	.57											
0.10	8.4	.15	.001	9	14	10	62	70	62	9.9	.57	.40	.057	.072	.050	7.6		29	.55				
0.20	8.6	.14	.001																				
0.30	8.8	.14	.001	10	15	5	65	71	65	10	2.3	.16	.044	.052	.029	8.0		28	.27				
0.40	8.8	.16	.001																				
0.50	8.9	.19	.001																				
0.60	9.0	.20	.001	8	13	11	67	76	59	11	5.8	.17	.042	.052	.028	7.7		29	.33				
0.70	9.0	.21	.002																				
0.80	9.0	.25	.008																				
0.90	8.9	.31	.017	8	13	12	66	74	57	12	7.9	.18	.047	.055	.028	7.2		30	.42				
1.00	8.8	.43	.036																				
1.10	8.7	.61	.060																				
1.20	8.6	.77	.075	13	17	14	53	61	47	10	8.0	.16	.065	.058	.048	5.2							
1.30	8.5	.90	.102																				
1.40	8.6	.87	.093																				
1.50	8.5	1.1	.126	37	22	8	31	40	27	6.9	6.5	0.1	.096	.086	.066	4.9							

Depth	Org.C	Tot.N	Extr. P		HCl	CaCl2 Extr		DTPA-extr.					Extractable			P		Alternative Cations				
	(W&B)		Acid	Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff	Equil	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg		meq%	mg/kg		mg/kg					mg/kg			Cap	ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C		@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	1.5	.15	28		.46			15	15	1.0	0.4											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Jeffray**

SITE NO: S1 A.M.G. REFERENCE: 554 900 mE 7 564 600 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.25
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded quartz

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall open woodland
DOMINANT SPECIES: Eucalyptus microtheca, Panicum queenslandicum, Muehlenbeckia cunninghamii

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Surface flake, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .02 m	Greyish yellow-brown (10YR4/2) moist, greyish yellow-brown (10YR4/2) dry; no mottles; medium heavy clay; no coarse fragments; strong 5-10mm subangular blocky secondary, parting to strong <2mm granular primary; dry; loose; no segregations. Gradual to-
B21	.02 to .85 m	Greyish yellow-brown (10YR4/2) moist; no mottles; medium heavy clay; very few small pebbles, subrounded quartz; moderate 50-100mm subangular blocky secondary, parting to moderate 20-50mm subangular blocky primary; dry; moderately strong; very few fine carbonate nodules. Abrupt to-
B22	.85 to 1.20 m	Greyish yellow-brown (10YR4/2) moist; no mottles; medium heavy clay; no coarse fragments; dry; very firm; few medium gypseous crystals, few fine manganiferous veins. Gradual to-
B23	1.20 to 1.45 m	Brown (7.5YR4/3) moist; few medium distinct gley mottles; medium heavy clay; no coarse fragments; lenticular; dry; very firm; few fine manganiferous veins. Diffuse to-
D	1.45 to 1.80 m	Dark greenish grey (10GY4/1) moist, brown (7.5YR4/3) moist; few fine prominent yellow mottles; medium heavy clay; no coarse fragments; lenticular; dry; very firm; no segregations.

Depth metres	pH @ 40C	EC dS/m @ 40C	Cl % @105C	CS FS S C % @ 105C	CEC	Ca Mg Na K m.eq/100g @ 105C	P	K S % @ 80C	ADM 33* 1500* % @ 105C	R1 R2 @ 40C	Al Acid m.eq/100g @ 105C	CaCl2 @ 40C
B 0.10	7.6	.05	.001									6.4
0.10	7.8	.06	.001	02 11 13 78	60	31 19 2.5 .20	.03	.01 .02	6.7 26	.56		6.5
0.20	8.2	.09	.005									6.8
0.30	8.2	.17	.016	01 10 12 81	59	31 19 4.7 .07	.02	.01 .02	6.5 27	.64		7.1
0.40	8.4	.24	.034									7.5
0.50	8.3	.45	.054									7.6
0.60	8.2	.62	.070	01 10 11 79	56	30 19 6.6 .05	.03	.01 .04	7.8 26	.71		7.6
0.70	8.1	.76	.083									7.6
0.80	7.6	1.6	.076									7.4
0.90	7.0	3.0	.096	01 11 11 79	54	31 18 7.6 .04	.03	.01 .53	6.6 27	.49		7.1
1.00	6.4	3.0	.112									6.6
1.10	6.0	2.1	.129									5.9
1.20	5.3	2.8	.141	01 11 14 77	47	25 15 6.6 .04	.03	.01 .49	5.4 27	.57		5.3
1.30	5.1	2.4	.152									4.9
1.40	4.8	3.3	.164									4.8
1.50	4.8	2.0	.177	01 14 15 74	46	22 15 6.8 .04	.02	.01 .15	6.1 26	.60		4.7

Depth metres	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Extr. P Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P mg/kg @ 105C	DTPA-extr. Fe	DTPA-extr. Mn	DTPA-extr. Cu	DTPA-extr. Zn	DTPA-extr. B mg/kg @ 105C	Extractable SO4S mg/kg @ 105C	Extractable NO3N mg/kg @ 105C	Extractable NH4N mg/kg @ 105C	P Buff Cap @ 40C	P Equil ug/L @ 40C	Alternative Cations CEC m.eq/100g @ 105C	Alternative Cations Ca m.eq/100g @ 105C	Alternative Cations Mg m.eq/100g @ 105C	Alternative Cations Na m.eq/100g @ 105C	Alternative Cations K m.eq/100g @ 105C
B 0.10	0.6	.05	13	22	.25			38	58	1.3	0.5											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Kenlogan**

SITE NO: S22 A.M.G. REFERENCE: 560 400 mE 7 526 500 mN ZONE 55

GREAT SOIL GROUP: Red-brown clay
PRINCIPAL PROFILE FORM: Ug5.37
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few small pebbles,subrounded quartz

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Low open woodland
DOMINANT SPECIES: Eucalyptus erythrophloia, Dichanthium sericeum

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .03 m	Dull reddish brown (5YR4/3) moist, greyish red (2.5YR4/2) dry; no mottles; medium heavy clay; no coarse fragments; strong 2-5mm granular secondary; dry; loose; no segregations. Clear to-
B21	.03 to .20 m	Dull reddish brown (5YR4/3) moist; no mottles; heavy clay; no coarse fragments; dry; very firm; no segregations. Clear to-
B22	.20 to .70 m	Dull reddish brown (5YR4/3) moist; no mottles; heavy clay; no coarse fragments; strong lenticular; dry; moderately strong; no segregations. Abrupt to-
2R	.70 to .72 m	Red (10R5/6) moist; no mottles; no segregations.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures		Disp.Ratio		Exch Exch ECEC		pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM 33*	1500*	R1	R2	Al	Acid	CaCl2
metres		dS/m	%		%				m.eq/100g					%			%				m.eq/100g	
	@ 40C		@105C		@ 105C				@ 105C					@ 80C			@ 105C	@ 40C			@ 105C	@ 40C
B 0.10	7.4	.05	.001					84	62	15	.28	.81										
0.10	7.3	.07	.001	2	7	9	77	82	57	15	.27	.67	.076	.148	.026	7.9	32	.41				
0.20	7.2	.14	.003																			
0.30	7.4	.06	.002	2	7	10	79	86	61	15	.41	.40	.074	.129	.021	10.1	32	.27				
0.40	7.4	.04	.001	2	7	8	78						.075	.129	.016	8.7	32	.30				
0.50	7.5	.04	.001																			
0.60	7.6	.05	.002	2	7	10	78	88	61	15	.52	.44	.075	.132	.015	9.6	32	.30				
0.70	7.7	.06	.001	4	8	8	76	75	59	15	.57	.44	.075	.127	.015	7.3	32	.33				

Depth	Org.C	Tot.N	Extr. P		HCl	CaCl2 Extr		DTPA-extr.					Extractable			P		Alternative Cations				
	(W&B)		Acid	Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff	Equil	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg		meq%	mg/kg		mg/kg					mg/kg			Cap	ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C		@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	1.2	.10		43	.69			28	62	1.7	0.4											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Kenlogan**

SITE NO: S25 A.M.G. REFERENCE: 573 200 mE 7 519 900 mN ZONE 55

GREAT SOIL GROUP: Red clay
PRINCIPAL PROFILE FORM: Ug5.37
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Few small pebbles, subrounded unspecified coarse fragments

DISTURBANCE OF SITE: Limited clearing
VEGETATION
STRUCTURAL FORM: Dwarf woodland
DOMINANT SPECIES: Eremophila mitchellii, Acacia salicina, Owenia acidula, Alstonia constricta

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Surface flake, self-mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .03 m	Dull reddish brown (2.5YR4/4) moist, dull reddish brown (2.5YR4/4) dry; no mottles; medium clay; no coarse fragments; strong 2-5mm granular; dry; loose; no segregations. Gradual to-
B21	.03 to .60 m	Dull reddish brown (2.5YR4/4) moist; no mottles; medium clay; no coarse fragments; strong 2-5mm subangular blocky; dry; moderately firm; no segregations. Gradual to-
B22	.60 to .80 m	Bright brown (2.5YR5/6) moist; no mottles; common medium pebbles, subangular basalt; dry; moderately firm; few medium carbonate soft segregations.
2R	.80 to 1.20 m	Red (10R5/6) moist; no mottles; no segregations.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS %	FS %	S %	C % @ 105C	Exch. Cations CEC m.eq/100g @ 105C	Ca m.eq/100g @ 105C	Mg m.eq/100g @ 105C	Na m.eq/100g @ 105C	K m.eq/100g @ 105C	Total Elements P % @ 80C	K % @ 80C	S % @ 80C	Moistures ADM 33* % @ 105C	1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Exch ECEC Al m.eq/100g @ 105C	Acid m.eq/100g @ 105C	pH CaCl2 @ 40C
metres																						
B 0.10	7.6	.04	.001					42	29	7.3	.23	1.0										
0.10	7.6	.10	.002	5	6	9	75	40	26	6.9	.18	.90	.105	.253	.056	4.5	23	.58				
0.20	7.6	.08	.002																			
0.30	7.8	.07	.002	3	5	12	76	37	25	4.8	.24	.30	.081	.149	.032	4.8	23	.17				
0.40	8.0	.10	.002																			
0.50	8.3	.07	.002																			
0.60	8.5	.07	.004	21	14	15	50	14	12	2.8	.13	.13	.055	.037	.042	2.4	17	.53				
0.70	8.6	.22	.010																			
0.80	8.6	.28	.022																			
1.10	8.5	1.0	.137																			

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb.	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe mg/kg @ 105C	Mn	Cu	Zn	B	Extractable SO4S mg/kg @ 105C	NO3N	NH4N	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K
metres																						
B 0.10	2.7	.19	31		.99			17	45	2.9	0.6											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Kenmar**

SITE NO: S37 A.M.G. REFERENCE: 577 400 mE 7 544 400 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.24
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Pellic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: .10 m
HORIZONTAL INTERVAL: 20 m
COMPONENT OF MICRORELIEF SAMPLED: Depression
SURFACE COARSE FRAGMENTS: Few medium pebbles, subrounded unspecified coarse fragments

DISTURBANCE OF SITE: Complete clearing
VEGETATION
STRUCTURAL FORM: Tall sparse shrubland
DOMINANT SPECIES: Acacia harpophylla, Atalaya hemiglauca, Carissa ovata, Cenchrus ciliaris, Chloris gayana

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .01 m	Brownish grey (7.5YR4/1) moist; no mottles; heavy clay; few medium pebbles, subrounded unspecified coarse fragments, common small pebbles, rounded quartz; strong 2-5mm subangular blocky secondary, parting to strong <2mm granular primary; dry; loose; very few fine carbonate soft segregations. Abrupt to-
B21	.01 to .50 m	Brownish grey (7.5YR4/1) moist; no mottles; heavy clay; very few coarse pebbles, subangular unspecified coarse fragments, few small pebbles, rounded quartz; moderately moist; very firm; very few medium carbonate nodules, few fine manganiferous veins. Gradual to-
B22	.50 to 1.50 m	Greyish yellow-brown (10YR5/2) moist; no mottles; heavy clay; few medium pebbles, subangular unspecified coarse fragments; dry; moderately strong; no segregations.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	33*	1500*	Disp.Ratio R1	R2	Exch Exch ECEC Al	Acid	pH CaCl2
metres	@ 40C	dS/m	@105C	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C			@ 40C		m.eq/100g @ 105C		@ 40C
B 0.10	8.4	.15	.001																				
0.01	7.6	.06	.001	22	18	17	45	31	16	10	.82	.63	.019	.068	.018	2.5		14	.54				
0.20	8.3	.16	.006													3.1							
0.30	8.0	.34	.033	21	14	12	52	36	18	12	4.4	.11	.008	.015	.021	3.0		17	.87				
0.40	6.2	.64	.079													2.1							
0.50	5.3	.87	.111													2.1							
0.60	5.0	.90	.119	19	13	14	52	36	13	11	5.6	.10	.006	.025	.030	2.2		18	.92				
0.70	4.9	.96	.136													2.5							
0.80	4.8	.96	.142													2.8							
0.90	4.7	1.0	.152	17	13	14	55	35	12	10	5.9	.10	.005	.024	.016	2.4		19	.93				
1.00	4.6	1.0	.159													2.5							
1.10	4.6	1.1	.166													1.9							
1.20	4.6	1.1	.166	15	13	15	55	35	11	10	5.7	.09	.006	.025	.012	2.2							
1.30	4.6	1.0	.159													2.1							
1.40	4.6	1.0	.160													2.4							
1.50	4.6	1.1	.158																				

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Bicarb.	HCl K	CaCl2 Extr K	P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil	Alternative Cations CEC	Ca	Mg	Na	K
metres	% @ 105C	% @ 105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C		mg/kg @ 105C					mg/kg @ 105C			@ 40C	ug/L	m.eq/100g @ 105C				
B 0.10	0.9	.09	18	9	.40			18	17	1.1	0.5											
0.01																		17	9.9	.99	.62	
0.60																		13	10	7.6	.08	
0.90																		12	10.0	8.1	.08	
1.20																		12	10	8.6	.07	

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol
Alternative cation method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Kenmar**

SITE NO: S42 A.M.G. REFERENCE: 577 400 mE 7 544 400 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.24
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Pellic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: .10 m
HORIZONTAL INTERVAL: 15 m
COMPONENT OF MICRORELIEF SAMPLED: Mound
SURFACE COARSE FRAGMENTS: Few medium pebbles, subrounded quartz

DISTURBANCE OF SITE: Complete clearing
VEGETATION
STRUCTURAL FORM: Tall open shrubland
DOMINANT SPECIES: Acacia harpophylla, Terminalia oblongata, Eucalyptus thozetiana, Apophyllum anomalum, Eremocitrus glauca, Cenchrus ciliaris

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Surface flake, self-mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .02 m	Greyish yellow-brown (10YR4/2) moist, greyish yellow-brown (10YR6/2) dry; no mottles; medium heavy clay; no coarse fragments; strong 2-5mm granular; dry; loose; very few fine carbonate nodules. Clear to-
B21	.02 to .60 m	Brownish grey (7.5YR5/1) moist; no mottles; medium heavy clay; very few medium pebbles, subrounded unspecified coarse fragments; dry; moderately strong; few fine carbonate nodules, very few medium carbonate soft segregations. Diffuse to-
B22	.60 to .90 m	Greyish brown (7.5YR5/2) moist; no mottles; heavy clay; no coarse fragments; dry; moderately strong; common fine gypseous crystals, few fine carbonate nodules. Clear to-
B23	.90 to 1.60 m	Dull brown (7.5YR5/3) moist; common medium faint grey mottles, very few fine faint orange mottles; heavy clay; very few small pebbles, subrounded quartz; strong lenticular; dry; very firm; few coarse gypseous crystals, very few fine manganiferous veins.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM 33*	1500*	Disp.Ratio R1 @ 40C	R2	Exch Al	Exch Acid	ECEC	pH CaCl2 @ 40C
metres				% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C				m.eq/100g @ 105C			
B 0.10	8.6	.13	.001																				
0.10	8.6	.15	.001	26	23	9	37	31	23	8.1	.44	.83	.025	.134	.059	5.2	14	.57					
0.20	8.9	.28	.007																				
0.30	9.1	.35	.011	26	21	10	40	31	19	11	2.1	.12	.012	.035	.043	3.3	14	.52					
0.40	9.3	.33	.008																				
0.50	8.7	.87	.013																				
0.60	8.4	1.6	.026	25	22	11	40	32	17	13	5.8	.11	.009	.025	.381	3.7	14	.57					
0.70	8.3	2.1	.041																				
0.80	8.1	2.5	.065																				
0.90	7.9	2.1	.097	22	21	7	46	33	15	15	8.6	.10	.011	.031	.432	4.4	16	.58					
1.00	6.4	1.6	.126																				
1.10	5.0	2.6	.135																				
1.20	4.7	2.5	.143	20	17	13	54	35	13	13	8.1	.13	.007	.032	.533	5.2							
1.30	4.4	3.2	.144																				
1.40	4.3	3.3	.147																				
1.50	4.6	1.6	.164																				

Depth	Org.C (W&B) @ 105C	Tot.N @ 105C	Extr. P Acid	Extr. P Bicarb.	HCl K	CaCl2 Extr K	CaCl2 Extr P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S	Extractable NO3N	Extractable NH4N	P Buff Cap	P Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K
metres	% @ 105C	% @ 105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C		mg/kg @ 105C					mg/kg @ 105C			@ 40C		m.eq/100g @ 105C				
B 0.10	0.9	.09	13	8	.37			13	15	1.1	0.3											
0.10																		27	7.4	.40	.75	
0.30																		32	11	2.5	.11	
0.90																		22	15	10	.08	
1.20																		25	13	11	.09	

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol
Alternative cation method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Kenmar, melonhole phase**

SITE NO: S43 A.M.G. REFERENCE: 580 600 mE 7 551 200 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Uf6.33
SOIL TAXONOMY UNIT: Calciorthid
FAO UNESCO UNIT: Calcic Xerosol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Upper slope
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Melonhole gilgai
VERTICAL INTERVAL: .70 m
HORIZONTAL INTERVAL: 20 m
COMPONENT OF MICRORELIEF SAMPLED: Mound
SURFACE COARSE FRAGMENTS: Many medium pebbles, subrounded unspecified coarse fragments

DISTURBANCE OF SITE: Complete clearing
VEGETATION
STRUCTURAL FORM: Tall sparse shrubland
DOMINANT SPECIES: Apophyllum anomalum, Cenchrus ciliaris

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A1	0 to .01 m	Brown (7.5YR4/3) moist, dull brown (7.5YR5/3) dry; no mottles; fine sandy medium clay; no coarse fragments; weak <2mm granular; dry; loose; no segregations. Clear to-
B21	.01 to 1.40 m	Dull orange (7.5YR6/4) moist; no mottles; medium heavy clay; very few medium pebbles, subrounded unspecified coarse fragments, few small pebbles, subrounded unspecified coarse fragments; dry; very firm; many coarse carbonate soft segregations, very few medium manganiferous veins. Gradual to-
B22	1.40 to 1.80 m	Dull orange (7.5YR6/4) moist; few medium faint grey mottles, very few fine distinct red mottles; medium heavy clay; very few small pebbles, subrounded unspecified coarse fragments; strong lenticular; dry; moderately strong; common medium manganiferous veins, very few fine carbonate nodules.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM 33*	1500*	Disp.Ratio R1	R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres	@ 40C	dS/m @105C	%	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C		@ 40C		m.eq/100g @ 105C			@ 40C
B 0.10	8.6	.15	.001																				
0.10	8.7	.13	.001	25	30	5	36	26	26	2.8	.21	.36	.061	.178	.131	5.1	12	.48					
0.20	8.8	.12	.001																				
0.30	9.1	.12	.001	20	24	15	44	25	23	4.6	.47	.15	.033	.075	.073	2.9	12	.27					
0.40	9.3	.12	.001																				
0.50	9.6	.16	.001																				
0.60	9.8	.20	.002	17	21	21	43	25	15	8.3	3.0	.10	.014	.035	.053	3.0	12	.42					
0.70	9.8	.26	.004																				
0.80	9.9	.33	.010																				
0.90	9.8	.41	.017	20	24	15	43	27	11	12	7.0	.10	.011	.042	.060	3.4	13	.64					
1.00	9.8	.52	.028																				
1.10	9.7	.64	.042																				
1.20	9.6	.82	.060	19	25	13	43	31	11	15	11	.10	.011	.039	.059	3.8							
1.30	9.6	.89	.067																				
1.40	9.6	.96	.079																				
1.50	9.0	1.0	.091																				

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Bicarb.	HCl K	CaCl2 Extr K	P	Fe	DTPA-extr. Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil	Alternative Cations CEC	Ca	Mg	Na	K
metres	% @ 105C	% @ 105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C			mg/kg @ 105C				mg/kg @ 105C			ug/L @ 40C		m.eq/100g @ 105C				
B 0.10	1.4	.09	33	12	.34			12	12	1.3	.26											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Kenmar, melonhole phase**

SITE NO: S44 A.M.G. REFERENCE: 580 600 mE 7 551 200 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.24
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Pellic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Melonhole gilgai
VERTICAL INTERVAL: .70 m
HORIZONTAL INTERVAL: 20 m
COMPONENT OF MICRORELIEF SAMPLED: Depression
SURFACE COARSE FRAGMENTS: Very few coarse pebbles, subangular unspecified coarse fragments

DISTURBANCE OF SITE: Complete clearing
VEGETATION
STRUCTURAL FORM: Tall sparse shrubland
DOMINANT SPECIES: Apophyllum anomalum, Cenchrus ciliaris

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Periodic cracking, self-mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .02 m	Greyish yellow-brown (10YR4/2) moist, brownish grey (10YR4/1) dry; no mottles; medium heavy clay; no coarse fragments; strong 5-10mm subangular blocky; dry; loose; no segregations. Clear to-
B21	.02 to .30 m	Brownish grey (7.5YR4/1) moist; no mottles; medium heavy clay; very few medium pebbles, subrounded unspecified coarse fragments; dry; moderately strong; common medium carbonate soft segregations. Clear to-
B22	.30 to .80 m	Brownish grey (7.5YR4/1) moist; no mottles; heavy clay; very few medium pebbles, subrounded unspecified coarse fragments; strong lenticular; dry; moderately strong; few medium carbonate nodules. Diffuse to-
B23	.80 to 1.70 m	Greyish yellow-brown (10YR5/2) moist, brownish grey (7.5YR4/1) moist; few medium prominent red mottles; heavy clay; very few medium pebbles, subrounded unspecified coarse fragments; strong lenticular; dry; moderately strong; few coarse manganiferous cutans.

Depth	1:5 Soil/Water pH	1:5 Soil/Water EC	1:5 Soil/Water Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	Total Elements K	Total Elements S	Moistures ADM 33*	Moistures 1500*	Disp.Ratio R1	Disp.Ratio R2	Exch Exch ECEC Al	Exch Exch ECEC Acid	pH CaCl2
metres		dS/m @ 40C	% @105C	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C		@ 40C		m.eq/100g @ 105C		@ 40C
B 0.10	8.5	.19	.003																			
0.10	8.5	.22	.004	16	14	16	50	51	43	5.9	.70	.67	.062	.145	.074	6.4	20	.56				
0.20	8.8	.18	.001																			
0.30	8.8	.18	.001	22	17	14	47	44	36	7.4	2.0	.17	.023	.056	.036	5.3	18	.44				
0.40	8.9	.15	.001																			
0.50	8.9	.12	.002																			
0.60	8.7	.21	.013	26	20	14	44	38	25	8.5	5.3	.15	.012	.043	.024	5.3	18	.84				
0.70	8.7	.28	.019																			
0.80	7.9	.42	.041																			
0.90	7.5	.47	.048	30	22	11	38	32	17	8.4	7.6	.10	.008	.027	.031	4.0	16	.92				
1.00	6.7	.61	.066																			
1.10	6.4	.64	.070																			
1.20	6.0	.68	.073	36	22	11	32	27	11	7.5	7.7	.10	.008	.029	.039	3.1						
1.30	5.8	.73	.081																			
1.40	5.6	.87	.104																			
1.50	5.5	.91	.111																			

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Extr. P Bicarb.	HCl K	CaCl2 Extr K	CaCl2 Extr P	DTPA-extr. Fe	DTPA-extr. Mn	DTPA-extr. Cu	DTPA-extr. Zn	DTPA-extr. B	Extractable SO4S	Extractable NO3N	Extractable NH4N	P Buff Cap	P Equil	Alternative Cations CEC	Ca	Mg	Na	K
metres	% @ 105C	% @ 105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C		mg/kg @ 105C					mg/kg @ 105C				ug/L @ 40C	m.eq/100g @ 105C				
B 0.10	1.0	.10	53	53	.76			26	6.5	1.8	.46											
0.10																		49	5.3	.66	.60	
0.30																		42	6.9	1.9	.15	
0.60																		24	8.0	5.7	.14	
0.90																		16	7.8	8.7	.09	
1.20																		11	7.1	9.2	.07	

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol
Alternative cation method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Lebanon**

SITE NO: S32 A.M.G. REFERENCE: 593 900 mE 7 545 200 mN ZONE 55

GREAT SOIL GROUP: No suitable group (affinities with solodized solonetz/solodic soil)
PRINCIPAL PROFILE FORM: Dy3.32
SOIL TAXONOMY UNIT: Typic Paleargid
FAO UNESCO UNIT: Luvic Xerosol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Nil

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Eucalyptus populnea, Eucalyptus papuana

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Hard setting

HORIZON	DEPTH	DESCRIPTION
A11	0 to .10 m	Greyish brown (5YR4/2) moist, brown (7.5YR4/3) dry; no mottles; sandy clay loam; no coarse fragments; massive; dry; moderately weak; no segregations. Clear to-
A12	.10 to .30 m	Dull brown (7.5YR5/4) moist; no mottles; sandy clay loam; no coarse fragments; massive; dry; moderately weak; no segregations. Abrupt to-
B1sb	.30 to .40 m	Dull orange (7.5YR6/4) moist, dry sporadically bleached; no mottles; sandy clay; very few small pebbles, subrounded unspecified coarse fragments; dry; moderately firm; no segregations. Clear to-
B2	.40 to .70 m	Bright brown (7.5YR5/6) moist; common medium prominent red mottles, few medium faint grey mottles; light medium clay; common small pebbles, subrounded unspecified coarse fragments; dry; very firm; very few fine manganiferous veins.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	33*	1500*	Disp.Ratio R1	R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres	@ 40C	dS/m @105C	%	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C			@ 40C		m.eq/100g @ 105C			@ 40C
B 0.10	7.1	.05	.001													1.0								
0.10	7.4	.03	.001	17	64	4	15	9	6.4	2.2	.09	.55	.026	.335	.029	0.8		4	.57					
0.20	6.9	.01	.001													0.6								
0.30	6.9	.01	.001	17	63	4	17	6	3.9	1.0	.05	.35	.020	.339	.014	0.7		4	.56					
0.40	7.0	.02	.001													0.9								
0.50	7.0	.03	.002													1.4								
0.60	7.3	.03	.002	12	41	4	44	11	6.6	2.5	.09	.66	.023	.646	.009	1.8		12	.30					
0.70	7.5	.03	.002													2.0								

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Bicarb.	HCl K	CaCl2 Extr K	P	Fe	DTPA-extr. Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil	Alternative Cations CEC	Ca	Mg	Na	K
metres	% @ 105C	% @105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C			mg/kg @ 105C				mg/kg @ 105C			@ 40C	ug/L	m.eq/100g @ 105C				
B 0.10	0.6	.04	5	3	.44			9	16	0.3	0.2											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Manar**

SITE NO: S11 A.M.G. REFERENCE: 553 000 mE 7 546 200 mN ZONE 55

GREAT SOIL GROUP: Brown clay
PRINCIPAL PROFILE FORM: Ug5.34
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: .10 m
HORIZONTAL INTERVAL: 10 m
COMPONENT OF MICRORELIEF SAMPLED: Mound
SURFACE COARSE FRAGMENTS: Very few medium pebbles, subrounded quartz

DISTURBANCE OF SITE: Complete clearing
VEGETATION
STRUCTURAL FORM: Tall sparse shrubland
DOMINANT SPECIES: Acacia cambagei, Canthium species, Apophyllum anomalum, Cenchrus ciliaris, Aristida species

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, surface flake

HORIZON	DEPTH	DESCRIPTION
A1	0 to .03 m	Dull reddish brown (5YR4/4) moist, brown (7.5YR4/3) dry; no mottles; medium clay; no coarse fragments; strong 2-5mm subangular blocky; dry; loose; few medium carbonate nodules, very few coarse carbonate nodules. Clear to-
B21	.03 to .30 m	Brown (7.5YR4/3) moist; no mottles; medium heavy clay; no coarse fragments; dry; very firm; few medium carbonate nodules. Gradual to-
B22	.30 to .60 m	Brown (7.5YR4/3) moist; no mottles; medium heavy clay; very few small pebbles, subrounded quartz; dry; moderately strong; few medium carbonate nodules, very few fine carbonate soft segregations. Diffuse to-
B23	.60 to 1.20 m	Brown (7.5YR4/3) moist; no mottles; medium heavy clay; no coarse fragments; dry; very firm; common fine gypseous crystals, very few medium carbonate nodules. Diffuse to-
B24	1.20 to 1.80 m	Brown (7.5YR4/4) moist; no mottles; medium heavy clay; no coarse fragments; dry; very firm; many medium manganiferous veins, few medium carbonate nodules.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS %	FS %	S %	C % @ 105C	Exch. Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K	Total Elements P % @ 80C	K %	S %	Moistures ADM % @ 105C	33* %	1500* %	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
B 0.10	8.5	.15	.003																					7.7
0.10	8.5	.15	.002	12	15	15	57	57	50	11	.43	.59	.09	.20	.08	8.0		22	.26					7.8
0.20	8.7	.17	.001																					7.8
0.30	8.7	.20	.002	07	15	15	64	55	42	15	1.6	.29	.05	.13	.08	7.3		27	.22					7.8
0.40	8.9	.25	.002																					7.9
0.50	8.9	.35	.004																					8.0
0.60	8.6	.71	.009	04	18	12	67	54	36	18	5.1	.16	.03	.08	.12	6.4		24	.28					7.9
0.70	8.2	1.6	.020																					8.0
0.80	8.0	2.8	.041																					7.8
0.90	7.8	3.6	.072	03	16	11	71	53	33	17	9.2	.13	.02	.06	1.27	6.6		25	.09					7.7
1.00	7.8	3.7	.143																					7.7
1.10	8.0	2.9	.203																					7.7
1.20	8.1	2.3	.249	03	17	12	68	55	37	17	11	.14	.02	.06	.26	6.7		25	.38					7.9
1.30	8.3	1.9	.272																					7.9
1.40	8.3	1.9	.300																					8.0
1.50	8.2	2.0	.241	02	17	14	69	56	33	16	11	.14	.01	.05	.08	6.8		25	.40					8.0

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb. mg/kg	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P mg/kg	DTPA-extr. Fe mg/kg	Mn	Cu	Zn	B	Extractable SO4S mg/kg @ 105C	NO3N	NH4N	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K
B 0.10	1.8	.18	60	58	.67			14	9	1.5	0.8											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Maraconda**

SITE NO: S2 A.M.G. REFERENCE: 552 000 mE 7 562 300 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.25
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: .10 m
HORIZONTAL INTERVAL: 1 m
COMPONENT OF MICRORELIEF SAMPLED: Depression
SURFACE COARSE FRAGMENTS: Very few small pebbles, subangular quartz

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Low isolated clump of trees
DOMINANT SPECIES: Acacia harpophylla, Panicum queenslandicum, Astrebla species

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Surface flake, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .02 m	Greyish brown (7.5YR4/2) moist, yellowish grey (2.5Y4/1) dry; no mottles; medium heavy clay; no coarse fragments; strong 10-20mm subangular blocky secondary, parting to moderate 2-5mm granular primary; dry; loose; no segregations. Gradual to-
B21	.02 to .30 m	Greyish brown (7.5YR4/2) moist; no mottles; medium heavy clay; very few small pebbles, subrounded quartz; moderate 50-100mm subangular blocky secondary, parting to moderate 10-20mm subangular blocky primary; dry; moderately strong; no segregations. Abrupt to-
B22	.30 to .80 m	Greyish brown (7.5YR4/2) moist; no mottles; medium heavy clay; no coarse fragments; lenticular; dry moderately strong; few medium gypseous crystals, few fine manganiferous veins. Diffuse to-
D1?	.80 to 1.30 m	Dull reddish brown (5YR4/3) moist; common medium distinct gley mottles, very few fine prominent yellow mottles; medium heavy clay; very few small pebbles, subrounded quartz; lenticular; dry; very firm; very few medium gypseous crystals. Diffuse to-
D2?	1.30 to 1.70 m	Greenish grey (7.5GY5/1) moist, dull reddish brown (5YR4/3) moist; very few fine prominent yellow mottles, very few medium prominent red mottles; medium heavy clay; no coarse fragments; lenticular;dry; very firm; no segregations.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P K S % @ 80C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 R2 @ 40C	Exch Exch ECEC Al Acid m.eq/100g @ 105C	pH CaCl2 @ 40C
B 0.10	6.9	.09	.006							5.9
0.10	6.7	.17	.019	03 16 18 68	43 17 14 1.8 .08	.02 .01 0.03	4.7 20	.56		5.9
0.20	6.4	.55	.067							5.9
0.30	6.1	1.5	.109	03 15 17 66	40 17 14 4.0 .06	0.01 .01 0.12	4.5 22	.42		5.9
0.40	5.9	2.8	.150							5.8
0.50	5.6	3.9	.184							5.6
0.60	5.4	4.0	.229	03 14 15 69	41 16 15 5.3 .03	0.01 .01 0.51	5.4 21	.50	0.04 0.06	5.4
0.70	5.2	4.4	.225							5.2
0.80	5.0	4.0	.228							5.0
0.90	4.9	2.6	.237	02 12 15 72	40 14 15 5.6 .03	0.02 .01 0.16	4.4 21	.51	0.16 0.22	4.8
1.00	4.9	2.1	.244							4.7
1.10	4.8	2.3	.255							4.6
1.20	4.6	2.9	.262	01 10 13 77	44 15 16 5.8 .04	0.01 .01 0.20	5.4 23	.52	0.32 0.45	4.5
1.30	4.6	2.6	.275							4.5
1.40	4.7	2.2	.287							4.4
1.50	4.6	2.2	.274	01 08 12 83	57 18 21 9.5 .03	0.01 .01 0.07	5.8 28	.56	0.45 0.68	4.4

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe Mn Cu Zn B mg/kg @ 105C	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC Ca Mg Na K m.eq/100g @ 105C
B 0.10	0.5	.04	4 5	.07			36 72 1.5 0.5				
0.10											40 17 14 2.4 .08
0.30											39 18 15 5.7 .04
0.60											38 40 17 9.3 .04
0.90											39 17 17 9.3 .04
1.20											42 24 19 10 .12
1.50											55 20 23 13 .03

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol
Alternative cation method: Extraction with 1M NH_4Cl at pH 7 Alternative CEC method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Maraconda**

SITE NO: S3 A.M.G. REFERENCE: 552 000 mE 7 562 300 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.25
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: .10 m
HORIZONTAL INTERVAL: 1 m
COMPONENT OF MICRORELIEF SAMPLED: Mound
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded quartz

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Low isolated clump of trees
DOMINANT SPECIES: Acacia harpophylla, Panicum queenslandicum, Astrebla species

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Surface flake, self-mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .02 m	Greyish yellow-brown (10YR4/2) moist, brownish grey (10YR4/1) dry; no mottles; medium heavy clay; no coarse fragments; weak 5-10mm subangular blocky secondary, parting to strong <2mm subangular blocky primary; dry; loose; no segregations. Abrupt to-
B21	.02 to .20 m	Greyish yellow-brown (10YR4/2) moist; no mottles; heavy clay; very few small pebbles, subrounded quartz; moderate 20-50mm subangular blocky secondary, parting to moderate 5-10mm subangular blocky primary; dry; moderately strong; no segregations. Clear to-
B22	.20 to 1.00 m	Greyish yellow-brown (10YR4/2) moist; no mottles; heavy clay; very few small pebbles, subrounded quartz; dry; moderately strong; common coarse gypseous crystals, very few fine manganiferous veins. Gradual to-
B23	1.00 to 1.50 m	Brown (7.5YR4/3) moist; few fine distinct gley mottles; heavy clay; no coarse fragments; lenticular dry; very firm; very few coarse gypseous crystals. Gradual to-
D?	1.50 to 1.70 m	Grey (N6/0) moist; common medium distinct red mottles; medium heavy clay; dry; moderately firm; very few medium gypseous crystals.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures		Disp.Ratio		Exch Exch ECEC		pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM 33*	1500*	R1	R2	Al	Acid	CaCl2
metres		dS/m	%		%				m.eq/100g					%			%				m.eq/100g		
	@ 40C		@105C		@ 105C				@ 105C					@ 80C			@ 105C	@ 40C			@ 105C	@ 40C
B 0.10	6.8	.08	.004																			5.8
0.10	6.9	.06	.002	04	16	17	66	44	27	8.5	.66	.19	.02	.01	.03	4.7	19	.48				6.0
0.20	6.0	1.9	.013																			6.0
0.30	5.9	2.7	.045	03	15	17	69	41	28	9.1	1.8	.04	.01	.01	.68	5.4	20	.32				5.9
0.40	5.9	3.2	.075																			5.8
0.50	5.8	3.6	.101																			5.8
0.60	5.7	3.9	.142	03	14	17	71	39	17	17	4.8	.03	.01	.01	.89	5.3	21	.20				5.6
0.70	5.6	4.0	.165																			5.5
0.80	5.3	4.2	.180																			5.3
0.90	5.1	3.2	.193	03	13	08	77	39	14	16	5.6	.04	.02	.01	.74	5.3	21	.52				5.1
1.00	5.0	3.4	.207																			4.9
1.10	4.9	2.8	.194																			4.8
1.20	4.8	2.4	.215	01	12	24	69	39	13	16	5.9	.09	.02	.01	.23	5.0	22	.51				4.6
1.30	4.8	1.8	.229																			4.5
1.40	4.7	2.1	.237																			4.5
1.50	4.9	2.2	.233	01	10	13	78	44	16	17	5.9	.06	.02	.01	.16	5.8	24	.50				4.5

Depth	Org.C (W&B)	Tot.N	Extr. P		HCl K	CaCl2 Extr		DTPA-extr.					Extractable			P		Alternative Cations				
			Acid	Bicarb.		K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff Cap	Equil ug/L	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg		meq%	mg/kg		mg/kg					mg/kg					m.eq/100g				
	@ 105C	@ 105C	@ 105C		@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	0.7	.05	5	8	.15			42	89	1.5	0.5											
0.10																		40	22	8.1	.90	.19
0.30																		40	50	9.2	2.6	.06
0.60																		39	52	18	7.6	.04
0.90																		39	44	18	9.3	.03
1.20																		39	18	18	9.7	.05
1.50																		44	16	17	5.9	.06

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol
Alternative cation method: Extraction with 1M NH_4Cl at pH 7
CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol
Alternative CEC method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Martyr**

SITE NO: S23 A.M.G. REFERENCE: 565 400 mE 7 551 700 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.2
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Pellic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: .15 m
HORIZONTAL INTERVAL: 10 m
COMPONENT OF MICRORELIEF SAMPLED: Depression
SURFACE COARSE FRAGMENTS: Very few coarse pebbles, subangular quartz

DISTURBANCE OF SITE: Limited clearing
VEGETATION
STRUCTURAL FORM: Mid-high woodland
DOMINANT SPECIES: Acacia cambagei, Terminalia oblongata, Acacia harpophylla, Eremophila mitchellii, Carissa ovata

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, surface flake

HORIZON	DEPTH	DESCRIPTION
A1	0 to .02 m	Brownish black (10YR3/1) moist, brownish grey (10YR4/1) dry; no mottles; medium clay; no coarse fragments; strong 2-5mm granular secondary; dry; loose; no segregations. Gradual to-
B21	.02 to .30 m	Brownish grey (10YR4/1) moist; no mottles; medium heavy clay; very few small pebbles, subrounded quartz; dry; moderately strong; no segregations. Gradual to-
B22	.30 to 1.10 m	Brownish grey (10YR4/1) moist; no mottles; medium heavy clay; very few small pebbles, subrounded quartz; dry; moderately strong; very few fine carbonate nodules. Diffuse to-
B23	1.10 to 1.50 m	Dull brown (7.5YR5/3) moist; no mottles; medium heavy clay; no coarse fragments; dry; moderately strong; common coarse carbonate nodules, few medium gypseous crystals. Gradual to-
D	1.50 to 1.80 m	Dull brown (7.5YR5/4) moist; few medium distinct gley mottles, few fine distinct orange mottles; fine sandy medium heavy clay; no coarse fragments; dry; very firm; few coarse carbonate soft segregations, few medium manganiferous veins.

Depth metres	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P K S % @ 80C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 R2 @ 40C	Exch Exch ECEC Al Acid m.eq/100g @ 105C	pH CaCl2 @ 40C
B 0.10	7.7	.14	.001		45 35 9.1 .65 .41					
0.10	7.1	.07	.001	21 16 11 47	40 25 9.8 1.3 .19	.015 .032 .027	4.2 18	.74		
0.20	7.4	.10	.007							
0.30	7.8	.21	.019	21 16 11 47	43 25 10 3.3 .12	.008 .018 .019	5.4 19	.61		
0.40	8.5	.40	.027							
0.50	7.9	1.1	.040							
0.60	7.5	1.6	.051	21 15 11 50	49 30 14 5.9 .09	.006 .015 .213	4.9 20	.51		
0.70	7.7	1.4	.066							
0.80	7.9	1.1	.094							
0.90	8.4	1.1	.101	18 14 13 53	46 27 14 6.4 0.1	.008 .022 .049	4.6 20	.55		
1.00	7.8	2.2	.115							
1.10	7.7	3.5	.118							
1.20	7.7	3.5	.125	18 21 4 54	39 24 12 5.7 .15	.017 .050 2.45	5.0			
1.30	7.8	3.4	.138							
1.40	8.1	2.0	.132							
1.50	8.4	1.4	.149		39 22 13 5.9 .20					
1.70	8.5	1.2	.155	13 38 10 35	37 21 11 5.7 .18	.037 .133 .030	3.8			

Depth metres	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P mg/kg	DTPA-extr. Fe Mn Cu Zn B mg/kg @ 105C	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Cap Equil ug/L @ 40C	Alternative Cations CEC Ca Mg Na K m.eq/100g @ 105C
B 0.10	1.1	.10	17	.38			23 31 1.1 0.7			

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Martyr**

SITE NO: S24 A.M.G. REFERENCE: 565 400 mE 7 551 700 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.24
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Pellic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: .15 m
HORIZONTAL INTERVAL: 10 m
COMPONENT OF MICRORELIEF SAMPLED: Mound
SURFACE COARSE FRAGMENTS: Very few coarse pebbles, subangular quartz

DISTURBANCE OF SITE: Limited clearing
VEGETATION
STRUCTURAL FORM: Mid-high woodland
DOMINANT SPECIES: Acacia cambagei, Terminalia oblongata, Acacia harpophylla, Eremophila mitchellii, Carissa ovata

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, surface flake

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Brownish grey (7.5YR4/1) moist, brownish grey (7.5YR4/1) dry; no mottles; fine sandy medium clay; no coarse fragments; strong 2-5mm subangular blocky secondary; dry; loose; few medium carbonate nodules. Clear to-
B21	.10 to .20 m	Brownish grey (7.5YR4/1) moist; no mottles; heavy clay; no coarse fragments; dry; very firm; no segregations. Gradual to-
B22	.20 to 1.10 m	Brownish grey (7.5YR4/1) moist; no mottles; heavy clay; very few small pebbles, subrounded quartz; dry; moderately strong; few medium carbonate nodules. Diffuse to-
B23	1.10 to 1.80 m	Dull brown (7.5YR5/3) moist; common medium distinct gley mottles, few medium distinct orange mottles; heavy clay; no coarse fragments; many medium carbonate nodules, few medium gypseous crystals, few medium manganiferous veins.

Depth metres	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS %	S %	C % @ 105C	Exch. Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K	Total Elements P % @ 80C	K % @ 80C	S % @ 80C	Moistures ADM 33* % @ 105C	1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid	ECEC	pH CaCl2 @ 40C
B 0.10	8.3	.16	.002				39	31	7.1	.32	.37											
0.10	8.5	.18	.002	25	20	10 40	40	29	9.0	.66	.24	.017	.047	.034	3.8	16	.66					
0.20	8.9	.18	.002																			
0.30	9.1	.20	.003	25	19	10 44	42	25	11	2.4	0.1	.007	.004	.019	4.0	16	.39					
0.40	9.2	.23	.005																			
0.50	9.2	.28	.010																			
0.60	9.1	.39	.018	22	18	10 47	44	24	15	5.1	.08	.005	.001	.028	4.8	18	.57					
0.70	8.9	.61	.031																			
0.80	8.2	1.4	.044																			
0.90	8.0	2.1	.059	19	15	11 52	48	27	17	7.0	.29	.005	.005	.471	5.6	19	.42					
1.00	7.9	2.4	.070																			
1.10	7.8	2.8	.084																			
1.20	7.8	3.5	.104	15	18	13 51	44	24	16	7.1	.13	.010	.031	1.34	5.4							
1.30	7.9	3.5	.109																			
1.40	7.8	3.5	.118																			
1.50	7.8	3.7	.133	12	31	11 43	41	24	15	7.4	.19	.025	.092	1.64	5.6							

Depth metres	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb.	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe	Mn	Cu	Zn	B mg/kg @ 105C	Extractable SO4S mg/kg @ 105C	NO3N	NH4N	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K
B 0.10	0.9	.09	9		.34			16	10	0.9	0.2										

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Midden**

SITE NO: S38 A.M.G. REFERENCE: 578 100 mE 7 553 800 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Uf6.31
SOIL TAXONOMY UNIT: Calciorthid
FAO UNESCO UNIT: Calcic Xerosol

SLOPE: 3 %
LANDFORM ELEMENT TYPE: Lower slope
LANDFORM PATTERN TYPE: Gently undulating plains

TYPE OF MICRORELIEF: Lattice gilgai
VERTICAL INTERVAL: .20 m
HORIZONTAL INTERVAL: 20 m
COMPONENT OF MICRORELIEF SAMPLED: Elongate mound
SURFACE COARSE FRAGMENTS: Common medium pebbles, subangular unspecified coarse fragments

DISTURBANCE OF SITE: Complete clearing
VEGETATION
STRUCTURAL FORM: Tall open shrubland
DOMINANT SPECIES: Acacia harpophylla, Terminalia oblongata, Cenchrus ciliaris

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Hard setting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .15 m	Brown (7.5YR4/4) moist, dark reddish brown (5YR3/3) dry; no mottles; sandy medium clay; few small pebbles, subangular unspecified coarse fragments; moderate 5-10mm subangular blocky; moderately moist; moderately firm; very few medium carbonate soft segregations, very few medium carbonate nodules. Gradual to-
B21	.15 to .75 m	Brown (7.5YR4/4) moist; no mottles; medium heavy clay; common small pebbles, subangular unspecified coarse fragments; moderately moist; very firm; few medium carbonate soft segregations, very few medium carbonate nodules. Gradual to-
B22	.75 to 1.45 m	Brown (7.5YR4/4) moist; no mottles; sandy medium heavy clay; common small pebbles, subangular unspecified coarse fragments; dry; moderately strong; few coarse carbonate soft segregations, few fine manganiferous nodules, few medium carbonate nodules. Abrupt to-
B23?	1.45 to 1.60 m	Brown (7.5YR4/4) moist; no mottles; medium clay; very few small pebbles, subangular unspecified coarse fragments; dry; very firm; many carbonate soft segregations, few medium carbonate nodules, very few fine manganiferous nodules.

Depth	1:5 Soil/Water pH	1:5 Soil/Water EC	1:5 Soil/Water Cl	Particle Size CS	Particle Size FS	Particle Size S	Particle Size C	Exch. Cations CEC	Exch. Cations Ca	Exch. Cations Mg	Exch. Cations Na	Exch. Cations K	Total Elements P	Total Elements K	Total Elements S	Moistures ADM	Moistures 33*	Moistures 1500*	Disp.Ratio R1	Disp.Ratio R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres		dS/m @ 40C	% @105C	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C			@ 40C		m.eq/100g @ 105C			@ 40C
B 0.10	8.5	.12	.001																					
0.10	8.5	.11	.001	22	31	11	35	32	29	3.0	.15	.28	.054	.089	.057	2.4		15	.38					
0.20	8.5	.12	.001													2.0								
0.30	8.6	.11	.001	20	28	15	36	32	29	4.9	.31	.11	.031	.025	.041	2.2		16	.35					
0.40	8.7	.13	.001													2.4								
0.50	8.8	.14	.001													2.5								
0.60	8.9	.18	.001	23	26	14	37	34	25	10	1.4	.07	.019	.011	.031	2.7		17	.39					
0.70	8.9	.23	.005													2.6								
0.80	8.9	.27	.011													2.5								
0.90	9.0	.29	.012	20	27	14	38	36	22	12	2.9	.07	.017	.011	.030	2.0		18	.44					
1.00	8.9	.38	.021													2.1								
1.10	8.8	.52	.034													2.2								
1.20	8.7	.71	.049	19	26	12	42	39	24	14	4.5	.07	.018	.014	.052	2.7								
1.30	8.1	2.1	.063													2.9								
1.40	7.9	3.1	.079													3.1								
1.60	8.1	2.0	.097													2.4								

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Extr. P Bicarb.	HCl K	CaCl2 Extr K	CaCl2 Extr P	DTPA-extr. Fe	DTPA-extr. Mn	DTPA-extr. Cu	DTPA-extr. Zn	DTPA-extr. B	Extractable SO4S	Extractable NO3N	Extractable NH4N	P Buff Cap	P Equil	Alternative Cations CEC	Alternative Cations Ca	Alternative Cations Mg	Alternative Cations Na	Alternative Cations K
metres	% @ 105C	% @ 105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C		mg/kg @ 105C					mg/kg @ 105C			@ 40C	ug/L	m.eq/100g @ 105C				
B 0.10	1.2	.13	13	12	.27			10	5	0.5	0.2											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Midden**

SITE NO: S39 A.M.G. REFERENCE: 578 100 mE 7 553 800 mN ZONE 55

GREAT SOIL GROUP: Black earth
PRINCIPAL PROFILE FORM: Ug5.15?
SOIL TAXONOMY UNIT: Mollic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 3 %
LANDFORM ELEMENT TYPE: Lower slope
LANDFORM PATTERN TYPE: Gently undulating plains

TYPE OF MICRORELIEF: Lattice gilgai
VERTICAL INTERVAL: .20 m
HORIZONTAL INTERVAL: 20 m
COMPONENT OF MICRORELIEF SAMPLED: Elongated depression
SURFACE COARSE FRAGMENTS: Common medium pebbles, subangular unspecified coarse fragments

DISTURBANCE OF SITE: Complete clearing
VEGETATION
STRUCTURAL FORM: Tall open shrubland
DOMINANT SPECIES: Acacia harpophylla, Terminalia oblongata, Cenchrus ciliaris

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .02 m	Dark reddish brown (5YR3/2) moist; no mottles; medium heavy clay; few medium pebbles, subrounded unspecified coarse fragments; strong 2-5mm subangular blocky secondary, parting to strong <2mm granular primary; dry; loose; very few fine carbonate soft segregations, few fine carbonate nodules. Abrupt to-
B21	.02 to .20 m	Dark reddish brown (5YR3/2) moist; no mottles; heavy clay; few medium pebbles, subrounded quartz, few medium pebbles, subangular unspecified coarse fragments; strong; moderately moist; moderately firm; few fine carbonate soft segregations, few fine carbonate nodules. Clear to-
B22	.20 to 1.00 m	Dark reddish brown (5YR3/2) moist; no mottles; heavy clay; few coarse pebbles, subangular unspecified coarse fragments; strong; moderately moist; moderately firm; few medium carbonate nodules, few fine carbonate soft segregations. Gradual to-
B23	1.00 to 1.30 m	Dull reddish brown (5YR4/4) moist; common coarse distinct dark mottles; heavy clay; no coarse fragments; moderately moist; moderately firm; common medium carbonate soft segregations, few medium carbonate nodules, few medium manganiferous nodules. Gradual to-
B24?	1.30 to 1.50 m	Dull reddish brown (5YR4/4) moist; few medium distinct yellow mottles; heavy clay; no coarse fragments; dry; moderately firm; many coarse carbonate soft segregations, few medium carbonate nodules, few medium manganiferous nodules.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS	FS	S	C (%) @ 105C	Exch. Cations CEC	Ca	Mg	Na	K (m.eq/100g @ 105C)	Total Elements P	K	S (% @ 80C)	Moistures ADM	33*	1500* (% @ 105C)	Disp.Ratio R1	R2 @ 40C	Exch Al	Exch Acid (m.eq/100g @ 105C)	ECEC	pH CaCl2 @ 40C
metres																								
B 0.10	8.4	.14	.001																					
0.02	8.4	.11	.001	24	20	11	43	49	43	5.5	.20	.83	.040	.138	.036	2.5		20	.34					
0.20	8.5	.16	.001													3.1								
0.30	8.8	.16	.001	24	17	8	50	53	44	7.8	2.0	.17	.026	.054	.032	3.4		23	.46					
0.40	8.9	.19	.003													3.2								
0.50	8.8	.29	.012													3.4								
0.60	8.7	.44	.029	22	17	8	53	56	40	10	4.9	.12	.021	.045	.036	3.7		24	.49					
0.70	8.6	.58	.047													4.1								
0.80	8.4	.97	.069													4.1								
0.90	7.9	2.1	.116	18	16	8	57	59	43	13	8.1	.13	.021	.040	.242	4.3		26	.44					
1.00	7.9	2.1	.128													3.8								
1.10	8.0	2.1	.132													3.7								
1.20	8.1	2.0	.146	14	20	10	53	53	35	11	7.6	.11	.026	.036	.226	3.9								
1.30	8.4	1.3	.155													4.1								
1.40	8.5	1.3	.157													4.0								
1.50	8.6	1.1	.137																					

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid	Bicarb. (mg/kg @ 105C)	HCl K meq% @105C	CaCl2 Extr K	P (mg/kg @ 105C)	Fe	DTPA-extr. Mn	Cu	Zn	B (mg/kg @ 105C)	Extractable SO4S	NO3N	NH4N (mg/kg @ 105C)	P Buff Cap	Equil ug/L @ 40C	Alternative Cations CEC	Ca	Mg	Na	K (m.eq/100g @ 105C)
metres																						
B 0.10	1.5	.13	28	9	.43			14	6	0.7	0.3											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.

SOIL TYPE: **Moramana**

SITE NO: S9 A.M.G. REFERENCE: 553 600 mE 7 541 700 mN ZONE 55

GREAT SOIL GROUP: Brown clay
PRINCIPAL PROFILE FORM: Ug5.3
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded unspecified coarse fragments

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Eucalyptus microtheca

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .03 m	Brown (7.5YR4/3) moist, brown (7.5YR4/3) dry; no mottles; medium heavy clay; no coarse fragments; strong 2-5mm subangular blocky; dry; loose; few medium carbonate nodules. Abrupt to-
B21	.03 to .25 m	Brown (7.5YR4/3) moist; no mottles; medium heavy clay; no coarse fragments; dry; very firm; very few medium carbonate nodules, very few fine carbonate nodules. Clear to-
B22	.25 to 1.30 m	Brown (7.5YR4/3) moist; no mottles; medium heavy clay; no coarse fragments; dry; very firm; very few medium carbonate nodules. Gradual to-
B23	1.30 to 1.85 m	Bright reddish brown (5YR5/6) moist; very few fine prominent yellow mottles; medium heavy clay; no coarse fragments; dry; moderately firm; common medium manganiferous veins, few coarse gypseous crystals.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P @ 80C	K @ 105C	S @ 105C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 @ 40C	R2 @ 105C	Exch Exch ECEC Al Acid m.eq/100g @ 105C	pH CaCl2 @ 40C
B 0.10	7.9	.10	.002	05 17 16 66	60 40 18 .88 .33				7.8	.25			7.1
0.10	8.0	.10	.001			.02	.07	.03	26				7.1
0.20	8.6	.10	.001										7.5
0.30	8.8	.11	.001	04 17 18 67	64 43 21 3.4 .11	.01	.05	.02	8.6 26	.30			7.7
0.40	8.9	.13	.002										7.7
0.50	8.9	.17	.008										7.8
0.60	8.9	.24	.017	02 17 15 67	61 38 22 6.3 .11	.01	.05	.03	9.0 27	.41			7.8
0.70	8.8	.38	.038										7.8
0.80	8.7	.49	.055										7.8
0.90	8.7	.73	.076	04 17 16 68	63 36 24 9.0 .11	.01	.05	.03	9.8 28	.43			7.9
1.00	8.7	.79	.083										7.9
1.10	8.4	.96	.095										7.8
1.20	8.4	1.0	.103	03 17 17 69	63 35 24 10 .12	.01	.07	.05	10.1 27	.44			7.8
1.30	8.3	1.2	.116										7.8
1.40	8.3	1.5	.115										7.9
1.50	8.0	2.0	.104	03 15 21 66	64 35 22 11 .14	.02	.07	.18	7.9 28	.42			7.8

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb.	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe	Mn	Cu	Zn	B mg/kg @ 105C	Extractable SO4S mg/kg @ 105C	NO3N	NH4N	P Buff Cap	Equil ug/L @ 40C	Alternative Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C
B 0.10	1.1	.10	10	8	.49			14	13	1.1	0.4											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Moramana, gilgai phase**

SITE NO: S48 A.M.G. REFERENCE: 554 400 mE 7 541 800 mN ZONE 55

GREAT SOIL GROUP: Red clay
PRINCIPAL PROFILE FORM: Ug5.38
SOIL TAXONOMY UNIT: Mollic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 1 %
LANDFORM ELEMENT TYPE: Upper slope
LANDFORM PATTERN TYPE: Gently undulating plains

TYPE OF MICRORELIEF: Lattice gilgai
VERTICAL INTERVAL: .20 m
HORIZONTAL INTERVAL: 8 m
COMPONENT OF MICRORELIEF SAMPLED: Elongate mound
SURFACE COARSE FRAGMENTS: Few small pebbles, subangular unspecified coarse fragments

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Eucalyptus microtheca, Atalaya hemiglauca, Acacia salicina, Bothriochloa decipiens, Panicum queenslandicum

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .02 m	Dark reddish brown (5YR3/3) moist, dark brown (7.5YR3/3) dry; no mottles; medium heavy clay; few small pebbles, subangular unspecified coarse fragments; moderate 2-5mm subangular blocky secondary, parting to moderate <2mm subangular blocky primary; dry; loose; few medium carbonate nodules. Abrupt to-
B21	.02 to .50 m	Dark reddish brown (5YR3/4) moist; no mottles; heavy clay; few small pebbles, subangular unspecified coarse fragments; moderate structure; moderately moist; very firm; very few medium carbonate nodules. Gradual to-
B22	.50 to 1.60 m	Dark reddish brown (5YR3/4) moist; no mottles; heavy clay; few small pebbles, subangular unspecified coarse fragments; dry; moderately strong; few medium carbonate nodules, very few coarse carbonate soft segregations, few fine manganiferous nodules. Clear to-
D	1.60 to 1.85 m	Brown (7.5YR4/4) moist; few fine distinct yellow mottles; medium clay; few medium pebbles, subrounded basalt, few small pebbles, subrounded unspecified coarse fragments; dry; very firm; many carbonate soft segregations, few medium carbonate nodules, common fine manganiferous nodules.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM 33*	1500*	Disp.Ratio R1	R2	Exch Exch ECEC Al	Acid	pH CaCl2
metres		dS/m	%	%				m.eq/100g					%			%				m.eq/100g		
	@ 40C		@105C	@ 105C				@ 105C					@ 80C			@ 105C		@ 40C		@ 105C		@ 40C
B 0.10	8.2	.13	.001																			
0.02	8.0	.18	.001	11	16	18	57	64	47	16	.21	1.9	.080	.285	.055	4.0	27	.25				
0.20	8.3	.18	.001													4.5						
0.30	8.4	.16	.001	5	16	14	65	67	49	19	.42	.25	.036	.061	.025	4.5	27	.23				
0.40	8.4	.16	.001													2.9						
0.50	8.5	.20	.001													3.7						
0.60	8.5	.20	.001	7	15	12	66	65	42	22	1.1	.20	.034	.058	.021	4.1	27	.27				
0.70	8.6	.21	.001													4.1						
0.80	8.7	.24	.003													4.5						
0.90	8.8	.26	.006	7	14	13	66	64	38	24	2.4	.17	.030	.055	.019	4.7	27	.34				
1.00	8.8	.27	.007													4.7						
1.10	8.8	.27	.008													2.9						
1.20	8.8	.29	.011	6	15	14	64	63	36	25	3.2	.16	.033	.061	.019	3.4						
1.30	8.8	.30	.013													3.4						
1.40	8.8	.34	.016													4.3						
1.50	8.9	.35	.018																			

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Bicarb.	HCl K	CaCl2 Extr K	P	Fe	DTPA-extr. Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil	Alternative Cations CEC	Ca	Mg	Na	K
metres	%	%	mg/kg		meq%	mg/kg			mg/kg				mg/kg			ug/L		m.eq/100g				
	@ 105C	@ 105C	@ 105C		@105C	@ 105C			@ 105C				@ 105C			@ 40C		@ 105C				
B 0.10	1.2	.11	16	9	.54			15	10	0.9	0.3											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Moramana, gilgai phase**

SITE NO: S49 A.M.G. REFERENCE: 554 400 mE 7 541 800 mN ZONE 55

GREAT SOIL GROUP: Red clay
PRINCIPAL PROFILE FORM: Ug5.37
SOIL TAXONOMY UNIT: Mollic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 1 %
LANDFORM ELEMENT TYPE: Upper slope
LANDFORM PATTERN TYPE: Gently undulating plains

TYPE OF MICRORELIEF: Lattice gilgai
VERTICAL INTERVAL: .20 m
HORIZONTAL INTERVAL: 8 m
COMPONENT OF MICRORELIEF SAMPLED: Elongated depression
SURFACE COARSE FRAGMENTS: Very few medium pebbles, subrounded quartz

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Eucalyptus microtheca, Atalaya hemiglauca, Acacia salicina, Bothriochloa decipiens, Panicum queenslandicum

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .02 m	Dark reddish brown (5YR3/3) moist; no mottles; heavy clay; no coarse fragments; strong 2-5mm subangular blocky secondary, parting to strong <2mm granular primary; dry; loose; very few fine carbonate nodules. Abrupt to-
B21	.02 to .35 m	Dark reddish brown (5YR3/3) moist; no mottles; heavy clay; no coarse fragments; strong; moderately moist; moderately firm; very few fine carbonate nodules. Diffuse to-
B22	.35 to 1.05 m	Dark reddish brown (5YR3/3) moist; no mottles; heavy clay; no coarse fragments; strong; moderately moist; moderately firm; very few medium carbonate nodules. Gradual to-
B23	1.05 to 1.30 m	Dull reddish brown (5YR4/4) moist; very few medium distinct yellow mottles, very few fine distinct orange mottles; heavy clay; few medium pebbles, subrounded unspecified coarse fragments; dry; very firm; few medium carbonate nodules, few medium carbonate soft segregations. Clear to-
D	1.30 to 1.40 m	Common medium pebbles, subrounded unspecified coarse fragments, common medium pebbles, subrounded basalt; many coarse carbonate nodules.

Depth metres	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P K S % @ 80C	Moistures ADM 33* 1500* % @ 105C		Disp.Ratio R1 R2 @ 40C	Exch Al Exch Acid ECEC m.eq/100g @ 105C	pH CaCl2 @ 40C
B 0.10	8.1	.10	.001								
0.02	7.7	.05	.001	3 11 18 69	86 47 22 .29 1.4	.070 .164 .031	5.2	30	.26		
0.20	8.0	.09	.001				3.5				
0.30	8.3	.09	.001	3 12 14 71	82 49 21 1.6 .24	.050 .053 .021	4.1	28	.35		
0.40	8.5	.09	.001				4.4				
0.50	8.7	.15	.001				4.3				
0.60	8.8	.14	.004	3 12 15 73	82 49 22 3.3 .17	.049 .052 .018	4.6	29	.34		
0.70	8.8	.16	.005				5.0				
0.80	8.8	.16	.007				5.3				
0.90	8.7	.25	.010	3 12 13 72	90 47 23 4.5 .17	.055 .058 .018	3.8	29	.41		
1.00	8.8	.30	.014				4.2				
1.10	8.8	.32	.017				3.7				
1.20	8.9	.32	.019	3 13 16 69	60 42 22 4.7 .18	.053 .055 .017	4.1				
1.30	9.0	.31	.017				3.8				
1.40	9.1	.28	.015				3.0				

Depth metres	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe Mn Cu Zn B mg/kg @ 105C	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Cap	Equil ug/L @ 40C	Alternative Cations CEC Ca Mg Na K m.eq/100g @ 105C
B 0.10	1.4	.13	20 17	.66			24 20 1.2 0.4				

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

55

SOIL TYPE: **Niagara**

SITE NO: S50 A.M.G. REFERENCE: 562 800 mE 7 538 800 mN ZONE 55

GREAT SOIL GROUP: Red clay
PRINCIPAL PROFILE FORM: Ug5.37
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: .05 m
HORIZONTAL INTERVAL: 10 m
COMPONENT OF MICRORELIEF SAMPLED: Mound
SURFACE COARSE FRAGMENTS: Nil

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall open forest
DOMINANT SPECIES: Acacia cambagei, Acacia harpophylla, Brachychiton rupestre, Terminalia oblongata, Erythroxylon australe, Carissa ovata

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .07 m	Dull reddish brown (5YR4/4) moist, dull reddish brown (5YR4/4) dry; no mottles; medium clay; no coarse fragments; strong 2-5mm granular; dry; loose; no segregations. Clear to-
B21	.07 to .40 m	Dull reddish brown (2.5YR4/4) moist; no mottles; medium clay; no coarse fragments; angular blocky; dry; moderately strong; no segregations. Clear to-
B22	.40 to .90 m	Dull reddish brown (2.5YR4/4) moist; no mottles; medium heavy clay; no coarse fragments; strong lenticular; dry; very firm; no segregations. Diffuse to-
B23	.90 to 1.50 m	Bright brown (2.5YR5/6) moist; no mottles; medium heavy clay; no coarse fragments; strong lenticular; dry; very firm; no segregations. Gradual to-
BC	1.50 to 1.70 m	Bright brown (2.5YR5/6) moist; no mottles; common fragments, basalt; dry; very firm; no segregations.

Depth	1:5 Soil/Water pH @ 40C	EC @105C	Cl %	Particle Size CS FS S C @ 105C	Exch. Cations CEC Ca Mg Na K @ 105C	Total Elements P %	K %	S % @ 80C	Moistures ADM 33* 1500* @ 105C	Disp.Ratio R1	R2 @ 40C	Exch Al @ 105C	Exch Acid @ 105C	ECEC @ 40C	pH CaCl2
metres		dS/m		%	m.eq/100g				%				m.eq/100g		
B 0.10	8.3	.20	.002												
0.10	8.4	.34	.005	4 13 13 66	61 41 23 .35 1.0	.038	.278	.084	7.3 29	.69					
0.20	8.5	.25	.004												
0.30	8.6	.28	.004	5 14 15 66	64 33 31 1.1 .45	.028	.178	.044	7.9 27	.27					
0.40	8.7	.31	.009												
0.50	8.7	.44	.017												
0.60	8.7	.58	.028	4 14 11 67	63 24 37 4.1 .36	.022	.161	.061	7.1 27	.38					
0.70	8.6	.82	.040												
0.80	8.6	.93	.051												
0.90	8.6	.98	.063	5 13 13 68	61 20 39 5.7 .31	.023	.140	.087	7.2 28	.37					
1.00	8.6	1.0	.071												
1.10	8.6	1.0	.081												
1.20	8.6	.99	.083	4 13 14 70	63 19 39 6.4 .34	.021	.133	.066	7.4						
1.30	8.6	1.0	.085												
1.40	8.7	.94	.083												
1.50	8.8	.92	.083												

Depth	Org.C (W&B) @ 105C	Tot.N @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe Mn Cu Zn B mg/kg @ 105C	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Cap Equil ug/L @ 40C	Alternative Cations CEC Ca Mg Na K m.eq/100g @ 105C
metres	%	%								
B 0.10	1.9	.17	10 9	1.3			16 20 1.4 .65			

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Nungaroo**

SITE NO: S28 A.M.G. REFERENCE: 569 200 mE 7 567 005 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Uf6.31
SOIL TAXONOMY UNIT: Calcic Gypsiorthid
FAO UNESCO UNIT: Gypsic Xerosol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: .25 m
HORIZONTAL INTERVAL: 10 m
COMPONENT OF MICRORELIEF SAMPLED: Mound
SURFACE COARSE FRAGMENTS: Few small pebbles, subrounded unspecified coarse fragments

DISTURBANCE OF SITE: Complete clearing
VEGETATION
STRUCTURAL FORM: Tall open tussock grassland
DOMINANT SPECIES: Cenchrus ciliaris

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A11	0 to .02 m	Dull reddish brown (5YR5/4) moist, dull reddish brown (5YR5/4) dry; no mottles; medium clay; no coarse fragments; moderate <2mm subangular blocky; dry; loose; no segregations. Clear to-
B21	.02 to .40 m	Dull reddish brown (5YR4/4) moist; no mottles; medium clay; very few small pebbles, subrounded quartz; moderate structure; dry; very firm; no segregations. Sharp to-
B22	.40 to .70 m	Dull reddish brown (5YR4/4) moist; no mottles; medium heavy clay; no coarse fragments; dry; moderately strong; common medium carbonate soft segregations, few medium manganiferous veins. Gradual to-
B23	.70 to 1.20 m	Dull reddish brown (5YR4/4) moist; no mottles; medium heavy clay; no coarse fragments; dry; moderately strong; many medium gypseous crystals, common medium manganiferous veins. Clear to-
B24	1.20 to 1.50 m	Dull reddish brown (5YR4/4) moist; common medium distinct gley mottles; heavy clay; no coarse fragments; dry; moderately strong; very few fine gypseous crystals. Clear to-
D?	1.50 to 1.80 m	Greenish grey (7.5GY6/1) moist; common medium prominent red mottles, common medium distinct brown mottles; heavy clay; very few small pebbles, subrounded quartz; dry; moderately strong; no segregations.

Depth metres	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P K S % @ 80C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 R2 @ 40C	Exch Exch ECEC Al Acid m.eq/100g @ 105C	pH CaCl2 @ 40C
B 0.10	8.1	.19	.002							
0.10	7.3	.10	.001	25 25 7 38	23 13 6.2 .36 .24	.031 .034 .058	2.4 12	.80		
0.20	7.3	.10	.001							
0.30	8.0	.12	.001	25 22 8 40	25 16 6.7 .65 .06	.019 .003 .028	3.0 13	.49		
0.40	8.7	.17	.002							
0.50	8.5	.45	.009							
0.60	7.8	2.7	.019	22 23 8 43	24 18 8.3 3.1 .05	.015 .001 1.26	3.8 14	.40		
0.70	7.7	2.9	.028							
0.80	7.7	3.1	.047							
0.90	7.5	3.2	.073	23 22 11 43	25 14 11 5.4 .05	.013 .001 1.41	3.5 15	.55		
1.00	7.2	3.2	.099							
1.10	5.8	3.1	.115							
1.20	4.7	2.8	.134	23 20 8 46	25 8.4 9.6 5.8 .04	.011 .001 .489	3.3			
1.30	4.5	1.8	.146							
1.40	4.3	1.8	.157							
1.50	4.5	1.3	.148							
1.70	4.3	1.4	.171	21 19 9 47	26 6.0 9.2 6.5 .03	.011 .001 .067	2.9			

Depth metres	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P mg/kg	DTPA-extr. Fe Mn Cu Zn B mg/kg @ 105C	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Cap @ 40C Equil ug/L	Alternative Cations CEC Ca Mg Na K m.eq/100g @ 105C
B 0.10	0.7	.05	9	.12			15 23 1.7 0.3			
0.10										14 5.9 .36 .22
0.30										18 6.4 .68 .04
0.60										55 7.6 3.5 .04
0.90										51 9.8 7.1 .03
1.20										25 9.8 8.8 .02
1.70										6.7 9.7 10 .02

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol
Alternative cation method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Nungaroo**

SITE NO: S29 A.M.G. REFERENCE: 569 200 mE 7 556 700 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Ug5.2
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: .25 m
HORIZONTAL INTERVAL: 10 m
COMPONENT OF MICRORELIEF SAMPLED: Depression
SURFACE COARSE FRAGMENTS: Few small pebbles, subrounded unspecified coarse fragments

DISTURBANCE OF SITE: Complete clearing
VEGETATION
STRUCTURAL FORM: Tall open tussock grassland
DOMINANT SPECIES: Cenchrus ciliaris

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Surface flake, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .02 m	Dull brown (7.5YR5/3) moist, greyish yellow-brown (10YR5/2) dry; no mottles; medium heavy clay; no coarse fragments; moderate 5-10mm granular; dry; loose; no segregations. Abrupt to-
B21	.02 to .20 m	Dull brown (7.5YR5/3) moist; many medium distinct gley mottles; medium heavy clay; very few small pebbles, subrounded quartz; dry; very strong; no segregations. Abrupt to-
B22	.20 to .60 m	Dull reddish brown (5YR5/4) moist; very few medium distinct gley mottles; medium heavy clay; no coarse fragments; dry; moderately strong; no segregations. Abrupt to-
B23	.60 to 1.50 m	Dull reddish brown (5YR4/4) moist; very few medium distinct gley mottles; medium heavy clay; no coarse fragments; moderately moist; very firm; no segregations. Diffuse to-
D?	1.50 to 1.80 m	Greenish grey (7.5GY6/1) moist, reddish brown (10R4/4) moist; common medium distinct brown mottles; heavy clay; no coarse fragments; dry; moderately strong; no segregations.

Depth (metres)	1:5 Soil/Water pH @ 40C	1:5 Soil/Water EC dS/m @105C	1:5 Soil/Water Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P % @ 80C	Total Elements K % @ 80C	Total Elements S % @ 105C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 @ 40C	Disp.Ratio R2 @ 40C	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
B 0.10	4.3	.10	.006		24 14 8.4 1.2 .22										
0.10	6.0	.11	.004	18 12 11 54	22 12 9.0 .87 .21	.033	.009	.043	3.2		.69				
0.20	5.8	.11	.006												
0.30	5.3	.24	.024	18 13 12 56	24 10 9.0 2.4 .04	.023	.001	.030	3.5	16	.50				
0.40	4.9	.52	.058												
0.50	4.6	.83	.103												
0.60	4.5	1.0	.144	18 12 16 54	23 7.8 8.7 6.1 .03	.018	.001	.039	3.6	16	.57				
0.70	4.4	1.1	.159												
0.80	4.4	1.1	.161												
0.90	4.3	1.1	.175	17 15 12 54	23 6.8 8.6 7.2 .04	.016	.001	.032	3.2	16	.58				
1.00	4.3	1.2	.183												
1.10	4.2	1.2	.180												
1.20	4.2	1.3	.193	18 15 11 53	22 6.1 7.8 7.8 .03	.016	.001	.016	2.8						
1.30	4.1	1.3	.196												
1.40	4.2	1.3	.213												
1.50	4.2	1.4	.214												
1.70	4.2	1.3	.205	19 18 10 51	24 6.7 8.5 8.9 .02	.012	.001	.026	3.6						

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Extr. P Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P mg/kg	DTPA-extr. Fe mg/kg @ 105C	DTPA-extr. Mn mg/kg @ 105C	DTPA-extr. Cu mg/kg @ 105C	DTPA-extr. Zn mg/kg @ 105C	DTPA-extr. B mg/kg @ 105C	Extractable SO4S mg/kg @ 105C	Extractable NO3N mg/kg @ 105C	Extractable NH4N mg/kg @ 105C	P Buff Cap @ 40C	P Equil ug/L @ 40C	Alternative Cations CEC m.eq/100g @ 105C	Alternative Cations Ca m.eq/100g @ 105C	Alternative Cations Mg m.eq/100g @ 105C	Alternative Cations Na m.eq/100g @ 105C	Alternative Cations K m.eq/100g @ 105C
B 0.10	1.2	.11		19	.22			114	49	2.7	0.8											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 7 CEC method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Ok**

SITE NO: S30 A.M.G. REFERENCE: 584 500 mE 7 547 000 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Uf6.31
SOIL TAXONOMY UNIT: Typic Torriorthent
FAO UNESCO UNIT: Luvic Xerosol

SLOPE: 3 %
LANDFORM ELEMENT TYPE: Mid slope
LANDFORM PATTERN TYPE: Gently undulating rises

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few medium pebbles, subrounded unspecified coarse fragments

DISTURBANCE OF SITE: Complete clearing
VEGETATION
STRUCTURAL FORM: Tall tussock grassland
DOMINANT SPECIES: Bothriochloa insculpta

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Poached, hard setting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Dark reddish brown (2.5YR3/3) moist; no mottles; light clay; no coarse fragments; moist; moderately weak; no segregations. Clear to-
B21	.10 to .35 m	Dark reddish brown (2.5YR3/4) moist; no mottles; light medium clay; very few small pebbles, subangular unspecified coarse fragments; moist; moderately firm; no segregations. Gradual to-
B22	.35 to .80 m	Dark reddish brown (2.5YR3/6) moist; common coarse distinct red mottles; medium heavy clay; few medium pebbles, subangular unspecified coarse fragments; moist; very firm; no segregations. Clear to-
D?	.80 to .95 m	Reddish brown (5YR4/6) moist; few fine distinct yellow mottles; medium clay; many medium pebbles, subangular; moderately moist; moderately firm; no segregations.

Depth	1:5 Soil/Water pH	1:5 Soil/Water EC	1:5 Soil/Water Cl	Particle Size CS	Particle Size FS	Particle Size S	Particle Size C	Exch. Cations CEC	Exch. Cations Ca	Exch. Cations Mg	Exch. Cations Na	Exch. Cations K	Total Elements P	Total Elements K	Total Elements S	Moistures ADM 33*	Moistures 1500*	Disp.Ratio R1	Disp.Ratio R2	Exch Exch Acid Al	ECEC	pH CaCl2
metres		dS/m	%		%			m.eq/100g					%			%				m.eq/100g		
	@ 40C	@105C		@ 105C				@ 105C					@ 80C			@ 105C		@ 40C		@ 105C		@ 40C
B 0.10	7.2	.04	.001																			
0.10	7.4	.04	.001	11	33	14	42	17	11	2.0	.12	1.3	.100	.457	.058	1.5	14	.53				
0.20	7.4	.04	.001													1.1						
0.30	7.6	.03	.001	13	30	11	49	14	10	1.8	.10	.71	.061	.396	.037	1.2	14	.55				
0.40	7.6	.03	.001													1.1						
0.50	7.7	.03	.001													1.6						
0.60	7.7	.03	.001	9	21	10	60	17	11	2.6	.09	.71	.042	.374	.021	1.7	18	.48				
0.70	7.7	.03	.001													1.8						
0.80	7.8	.03	.001													2.0						
0.90	7.7	.05	.001	16	16	11	58	21	14	4.6	.26	.47	.028	.221	.071	1.6	22	.57				

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Extr. P Bicarb.	HCl K	CaCl2 Extr K	CaCl2 Extr P	DTPA-extr. Fe	DTPA-extr. Mn	DTPA-extr. Cu	DTPA-extr. Zn	DTPA-extr. B	Extractable SO4S	Extractable NO3N	Extractable NH4N	P Buff Cap	P Equil	Alternative Cations CEC	Alternative Cations Ca	Alternative Cations Mg	Alternative Cations Na	Alternative Cations K
metres	%	%	mg/kg		meq%	mg/kg		mg/kg					mg/kg				ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C		@105C	@ 105C		@ 105C					@ 105C				@ 40C	@ 105C				
B 0.10	1.5	.12	26	17	.99			22	37	1.2	1.0											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Rankin**

SITE NO: S46 A.M.G. REFERENCE: 585 700 mE 7 538 900 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.22P
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 1 %
LANDFORM ELEMENT TYPE: Upper slope
LANDFORM PATTERN TYPE: Gently undulating plains

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few medium pebbles, subrounded unspecified coarse fragments

DISTURBANCE OF SITE: Rainfed cultivation

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
AP	0 to .10 m	Greyish yellow-brown (10YR5/2) moist, greyish yellow-brown (10YR6/2) dry; no mottles; medium clay; no coarse fragments; strong <2mm granular; dry; loose; few medium carbonate nodules. Clear to-
B21	.10 to .30 m	Greyish brown (7.5YR4/2) moist; no mottles; medium heavy clay; very few small pebbles, subrounded quartz; dry; very firm; very few medium carbonate nodules. Clear to-
B22	.30 to 1.10 m	Greyish brown (7.5YR4/2) moist; no mottles; medium heavy clay; no coarse fragments; strong lenticular; dry; moderately strong; few fine carbonate nodules. Gradual to-
BD?	1.10 to 1.50 m	Brownish grey (7.5YR4/1) moist, light yellowish orange (7.5YR8/4) moist; medium heavy clay; no coarse fragments; dry; very firm; few coarse gypseous crystals. Abrupt to-
D?	1.50 to 1.80 m	Light yellowish orange (7.5YR8/4) moist, light grey (5Y8/1) moist; very abundant fragments, ash; few medium manganiferous veins.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures		Disp.Ratio		Exch Exch ECEC		pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM 33*	1500*	R1	R2	Al	Acid	CaCl2
metres		dS/m	%			%			m.eq/100g					%			%				m.eq/100g	
	@ 40C	@105C				@ 105C			@ 105C					@ 80C			@ 105C	@ 40C			@ 105C	@ 40C
B 0.10	8.7	.22	.002																			
0.10	8.6	.25	.002	7	22	18	53	50	38	12	.64	1.0	.051	.481	.071	5.4	25	.74				
0.20	8.7	.24	.002																			
0.30	9.0	.23	.005	4	20	15	58	49	31	20	1.7	.47	.036	.356	.033	5.9	21	.33				
0.40	9.1	.29	.013																			
0.50	9.2	.38	.024																			
0.60	9.1	.55	.051	4	20	17	59	51	19	29	4.9	.42	.029	.361	.037	6.0	22	.43				
0.70	9.0	.87	.090																			
0.80	8.9	1.2	.128																			
0.90	8.7	1.6	.190	4	18	18	58	52	17	31	10	.49	.024	.360	.087	6.3	24	.49				
1.00	8.7	1.8	.240																			
1.10	8.2	3.5	.220																			
1.20	8.2	3.7	.213	1	16	23	58	28	11	18	4.8	.20	.013	.417	1.05	3.5						
1.30	8.3	2.9	.201																			
1.40	8.5	2.0	.189																			
1.50	8.8	1.4	.177																			

Depth	Org.C	Tot.N	Extr. P		HCl	CaCl2 Extr		DTPA-extr.					Extractable			P		Alternative Cations				
	(W&B)		Acid	Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff	Equil	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg		meq%	mg/kg		mg/kg					mg/kg			Cap	ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C		@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	1.7	.14	102	17	.82			7.3	7.1	.69	.30											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Russell**

SITE NO: S21 A.M.G. REFERENCE: 567 800 mE 7 529 800 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.22
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 1 %
LANDFORM ELEMENT TYPE: Upper slope
LANDFORM PATTERN TYPE: Gently undulating plains

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded quartz

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall sparse shrubland
DOMINANT SPECIES: Acacia victoriae, Acacia salicina, Dichanthium sericeum

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .04 m	Dull reddish brown (5YR4/3) moist, greyish brown (5YR4/2) dry; no mottles; medium clay; no coarse fragments; strong 2-5mm granular secondary; dry; loose; very few medium carbonate nodules. Gradual to-
B21	.04 to .20 m	Greyish brown (5YR4/2) moist; no mottles; medium heavy clay; no coarse fragments; dry; very firm; very few fine carbonate nodules. Gradual to-
B22	.20 to .60 m	Greyish brown (5YR4/2) moist; no mottles; medium heavy clay; no coarse fragments; strong lenticular; dry; very firm; very few fine carbonate nodules. Clear to-
BC	.60 to .70 m	Dull reddish brown (5YR4/3) moist; no mottles; many fragments, basalt; dry; moderately firm; few medium carbonate soft segregations. Clear to-
C	.70 to 1.20 m	Very abundant fragments, basalt; few very coarse carbonate soft segregations.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @105C	Cl % @105C	Particle Size CS FS % @ 105C	S %	C %	Exch. Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K	Total Elements P @ 80C	K	S	Moistures ADM 33* @ 105C	1500*	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid	ECEC	pH CaCl2 @ 40C
metres																					
B 0.10	8.4	.13	.001				102	86	14	.41	0.9										
0.10	8.2	.13	.001	3	8	14	70	107	89	14	.28	1.2	.046	.239	.031	10.7	39	.51			
0.20	8.3	.14	.001																		
0.30	8.4	.15	.001	1	8	12	74	105	88	16	.36	.45	.040	.180	.023	11.9	38	.29			
0.40	8.4	.14	.001																		
0.50	8.4	.14	.001																		
0.60	8.4	.16	.001	2	9	10	74	106	89	18	.41	.50	.038	.174	.022	10.7	38	.29			
0.70	8.5	.14	.001																		
0.80	8.4	.14	.001					96	76	17	.39	.17									

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb.	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	Fe	DTPA-extr. Mn mg/kg @ 105C	Cu	Zn	B	Extractable SO4S mg/kg @ 105C	NO3N	NH4N	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K
metres																						
B 0.10	1.3	.12		17	.75			14	15	1.5	0.4											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Russell**

SITE NO: S51 A.M.G. REFERENCE: 562 700 mE 7 538 800 mN ZONE 55

GREAT SOIL GROUP: Grey-brown clay
PRINCIPAL PROFILE FORM: Ug5.37
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few coarse pebbles, subangular basalt

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Mid-high woodland
DOMINANT SPECIES: Eucalyptus erythrophloia, Acacia salicina, Terminalia oblongata, Panicum species, Dichanthium sericeum

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .03 m	Dull reddish brown (5YR4/3) moist, greyish brown (5YR4/2) dry; no mottles; medium heavy clay; no coarse fragments; strong 2-5mm granular; dry; loose; very few medium carbonate nodules. Clear to-
B21	.03 to .20 m	Dull reddish brown (5YR4/3) moist; no mottles; medium heavy clay; no coarse fragments; angular blocky; dry; moderately strong; very few fine carbonate nodules. Clear to-
B22	.20 to .80 m	Dull reddish brown (5YR4/3) moist; no mottles; medium heavy clay; no coarse fragments; strong lenticular; dry; very firm; very few fine carbonate nodules. Clear to-
C	.80 to 1.00 m	Very abundant fragments, basalt; few fine manganiferous veins.

Depth	1:5 Soil/Water pH	1:5 Soil/Water EC	1:5 Soil/Water Cl	Particle Size CS	Particle Size FS	Particle Size S	Particle Size C	Exch. Cations CEC	Exch. Cations Ca	Exch. Cations Mg	Exch. Cations Na	Exch. Cations K	Total Elements P	Total Elements K	Total Elements S	Moistures ADM 33*	Moistures 1500*	Disp.Ratio R1	Disp.Ratio R2	Exch Exch ECEC Al	Exch Exch ECEC Acid	pH CaCl2
metres		dS/m	%		%			m.eq/100g						%			%				m.eq/100g	
	@ 40C	@105C		@ 105C				@ 105C					@ 80C			@ 105C		@ 40C			@ 105C	@ 40C
B 0.10	7.8	.13	.004																			
0.10	7.9	.09	.001	1	11	10	73	77	39	31	.30	1.2	.033	.263	.034	8.2	34	.58				
0.20	8.1	.06	.001																			
0.30	8.3	.07	.001	1	10	13	74	79	41	34	.55	.65	.030	.230	.021	9.6	31	.31				
0.40	8.4	.09	.001																			
0.50	8.6	.09	.001																			
0.60	8.7	.11	.001	2	10	10	77	78	38	38	1.2	.59	.029	.223	.018	9.4	32	.33				
0.70	8.8	.14	.001																			
0.80	8.8	.19	.001																			
0.90	9.0	.16	.001	35	34	14	15	73	35	37	1.9	.16	.150	.433	.012	9.4	21	.57				

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Extr. P Bicarb.	HCl K	CaCl2 Extr K	CaCl2 Extr P	DTPA-extr. Fe	DTPA-extr. Mn	DTPA-extr. Cu	DTPA-extr. Zn	DTPA-extr. B	Extractable SO4S	Extractable NO3N	Extractable NH4N	P Buff Cap	P Equil	Alternative Cations CEC	Alternative Cations Ca	Alternative Cations Mg	Alternative Cations Na	Alternative Cations K
metres	%	%	mg/kg		meq%	mg/kg		mg/kg					mg/kg				ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C		@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	1.0	.10	13	9	1.3			16	43	1.6	.44											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Solferino**

SITE NO: S41 A.M.G. REFERENCE: 554 100 mE 7 534 600 mN ZONE 55

GREAT SOIL GROUP: Brown clay
PRINCIPAL PROFILE FORM: Ug5.32
SOIL TAXONOMY UNIT: Mollic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Few medium pebbles, subangular quartz

DISTURBANCE OF SITE: Limited clearing
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Acacia cambagei, Acacia harpophylla, Eremophila mitchellii, Ehretia membranifolia, Cenchrus ciliaris

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .05 m	Dark brown (7.5YR3/3) moist, dark brown (7.5YR3/3) dry; no mottles; medium heavy clay; few small pebbles, subangular quartz; strong 2-5mm granular secondary, parting to strong <2mm granular primary; dry; loose; very few medium carbonate nodules. Clear to-
B21	.05 to .45 m	Dark brown (7.5YR3/3) moist; no mottles; heavy clay; very few small pebbles, subangular unspecified coarse fragments; moderately moist; very firm; very few medium carbonate soft segregations, very few fine manganiferous nodules. Diffuse to-
B22	.45 to 1.35 m	Brown (7.5YR4/3) moist; no mottles; heavy clay; very few small pebbles, subangular unspecified coarse fragments; dry; moderately strong; very few medium carbonate soft segregations, very few fine manganiferous nodules. Clear to-
D	1.35 to 1.50 m	Dull brown (7.5YR5/4) moist; few medium distinct orange mottles; medium heavy clay; common medium pebbles, subrounded basalt; moderately moist; moderately firm; few coarse carbonate soft segregations.

Depth	1:5 Soil/Water pH	1:5 Soil/Water EC dS/m @ 40C	1:5 Soil/Water Cl % @105C	Particle Size CS %	Particle Size FS %	Particle Size S %	Particle Size C %	Exch. Cations CEC m.eq/100g @ 105C	Exch. Cations Ca m.eq/100g @ 105C	Exch. Cations Mg m.eq/100g @ 105C	Exch. Cations Na m.eq/100g @ 105C	Exch. Cations K m.eq/100g @ 105C	Total Elements P % @ 80C	Total Elements K % @ 80C	Total Elements S % @ 80C	Moistures ADM 33* % @ 105C	Moistures 1500* % @ 105C	Disp.Ratio R1 @ 40C	Disp.Ratio R2 @ 40C	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
metres																							
B 0.10	8.4	.22	.003																				
0.05	7.8	.43	.003	14	6	16	61	71	53	18	.37	5.5	.146	.877	.178	4.0	44	.36					
0.20	8.3	.26	.004	7	8	16	64	63	43	18	.64	3.1	.107	.696	.072	3.1	35	.38					
0.30	8.7	.32	.003	7	9	15	71	59	33	23	3.5	1.2	.085	.503	.055	3.4	33	.44					
0.40	9.0	.55	.013													3.7							
0.50	9.0	1.2	.215													3.8							
0.60	9.0	2.3	.293	6	9	14	74	57	10	30	21	.85	.062	.411	.087	4.2	34	.84					
0.70	9.0	3.1	.418													4.5							
0.80	9.0	3.2	.480													4.8							
0.90	9.0	3.3	.493	4	8	14	75	58	7.3	28	29	.91	.053	.392	.067	2.7	35	.93					
1.00	9.0	3.1	.521													3.1							
1.10	9.0	3.1	.483													3.2							
1.20	9.0	3.1	.467	5	9	13	75	60	7.2	28	31	.76	.045	.352	.041	4.3							
1.30	9.0	3.1	.486													4.6							
1.40	9.1	2.8	.424													4.8							
1.50	9.2	2.8	.420																				

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Extr. P Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P mg/kg @ 105C	DTPA-extr. Fe mg/kg @ 105C	DTPA-extr. Mn mg/kg @ 105C	DTPA-extr. Cu mg/kg @ 105C	DTPA-extr. Zn mg/kg @ 105C	DTPA-extr. B mg/kg @ 105C	Extractable SO4S mg/kg @ 105C	Extractable NO3N mg/kg @ 105C	Extractable NH4N mg/kg @ 105C	P Buff Cap @ 40C	P Equil ug/L @ 40C	Alternative Cations CEC m.eq/100g @ 105C	Alternative Cations Ca m.eq/100g @ 105C	Alternative Cations Mg m.eq/100g @ 105C	Alternative Cations Na m.eq/100g @ 105C	Alternative Cations K m.eq/100g @ 105C
metres																						
B 0.10	2.1	.20	138	52	1.7			19	7	1.4	0.6											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Vicenza**

SITE NO: S8 A.M.G. REFERENCE: 558 100 mE 7 553 800 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.24
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: .10 m
HORIZONTAL INTERVAL: 10 m
COMPONENT OF MICRORELIEF SAMPLED: Depression
SURFACE COARSE FRAGMENTS: Very few medium pebbles, subrounded quartz

DISTURBANCE OF SITE: Limited clearing
VEGETATION
STRUCTURAL FORM: Mid-high open forest
DOMINANT SPECIES: Acacia cambagei, Acacia harpophylla, Eremophila mitchellii, Carissa ovata

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Greyish yellow-brown (10YR4/2) moist; no mottles; heavy clay; no coarse fragments; moist; moderately firm; no segregations. Abrupt to-
B21	.10 to .35 m	Greyish yellow-brown (10YR4/2) moist; no mottles; medium heavy clay; no coarse fragments; dry; moderately strong; few fine carbonate nodules. Abrupt to-
B22	.35 to 1.05 m	Greyish yellow-brown (10YR4/2) moist; no mottles; heavy clay; very few medium pebbles, subrounded quartz; dry; moderately strong; very few fine carbonate nodules. Clear to-
B23	1.05 to 1.35 m	Dull reddish brown (5YR5/4) moist, greyish yellow-brown (10YR4/2) moist; heavy clay; no coarse fragments; dry; very firm; many medium manganiferous veins, few medium gypseous crystals. Abrupt to-
B24	1.35 to 1.70 m	Dull reddish brown (5YR5/4) moist; very few fine distinct gley mottles; heavy clay; no coarse fragments; dry; very firm; common coarse gypseous crystals.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM 33*	1500*	Disp.Ratio R1	R2	Exch Acid Al	Exch Acid	ECEC	pH CaCl2
metres		dS/m	%		%			m.eq/100g					%			%				m.eq/100g		
	@ 40C		@105C		@ 105C			@ 105C					@ 80C			@ 105C	@ 40C			@ 105C		@ 40C
B 0.10	7.4	.15	.002				43	32	10	.47	.30											
0.10	7.3	.11	.001	8	15	16 61	42	28	13	.64	.24	.01	.02	.03	4.3	19	.38					
0.20	7.8	.11	.003																			
0.30	8.5	.12	.004	7	15	16 61	45	30	13	2.5	.19	.01	.01	.02	4.6	20	.42					
0.40	8.8	.21	.010																			
0.50	8.6	.30	.020																			
0.60	8.6	.49	.040	8	14	15 62	43	23	15	5.3	.05	.01	.01	.04	4.7	20	.54					
0.70	8.5	.66	.055																			
0.80	8.4	.83	.067																			
0.90	8.2	1.2	.079	7	14	15 64	45	23	17	5.5	.05	.01	.01	.10	4.5	20	.44					
1.00	7.6	3.0	.106																			
1.10	7.6	2.3	.122																			
1.20	7.2	3.0	.137	7	15	14 63	42	22	16	6.9	.05	.01	.01	.71	5.3							
1.30	5.9	3.7	.147																			
1.40	5.0	3.8	.156																			
1.50	4.7	3.5	.164	5	15	13 65	41	18	14	6.2	.11	.01	.02	.74	6.2							

Depth	Org.C (W&B) %	Tot.N %	Extr. P Acid	Bicarb.	HCl K	CaCl2 Extr K	P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K
metres	@ 105C	@ 105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C		mg/kg @ 105C					mg/kg @ 105C			@ 40C		m.eq/100g @ 105C				
B 0.10	1.0	.09	10		.29			23	35	1.1	0.4											
0.10																		26	14	.65	.20	
0.30																		27	14	2.4	.08	
0.60																		24	15	5.9	.03	
0.90																		25	17	7.5	.06	
1.20																		36	17	8.6	.06	
1.50																		49	17	8.8	.08	

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol
Alternative cation method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Vicenza**

SITE NO: S17 A.M.G. REFERENCE: 554 300 mE 7 556 200 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.24P
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0.2 %
LANDFORM ELEMENT TYPE: Mid slope
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded quartz

DISTURBANCE OF SITE: Rainfed cultivation

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
AP	0 to .30 m	Greyish yellow-brown (10YR4/2) moist; no mottles; medium heavy clay; no coarse fragments; strong <2mm granular; moist; moderately weak; very few medium carbonate nodules. Clear to-
B21	.30 to .80 m	Greyish yellow-brown (10YR4/2) moist; no mottles; heavy clay; no coarse fragments; strong lenticular; dry; very firm; very few medium carbonate nodules, very few medium carbonate soft segregations. Diffuse to-
B22	.80 to 1.40 m	Dull brown (7.5YR5/3) moist; no mottles; medium heavy clay; no coarse fragments; dry; very firm; common coarse gypseous crystals, few medium manganiferous veins. Diffuse to-
B23	1.40 to 1.70 m	Dull reddish brown (5YR5/4) moist; few medium distinct grey mottles, few fine distinct gley mottles; medium heavy clay; no coarse fragments; strong lenticular; dry; moderately firm; many medium manganiferous veins.

Depth	1:5 Soil/Water pH	1:5 Soil/Water EC	1:5 Soil/Water Cl	Particle Size CS FS	Particle Size S	Particle Size C	Exch. Cations CEC	Exch. Cations Ca	Exch. Cations Mg	Exch. Cations Na	Exch. Cations K	Total Elements P	Total Elements K	Total Elements S	Moistures ADM 33*	Moistures 1500*	Disp.Ratio R1	Disp.Ratio R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres	@ 40C	dS/m @105C	%		% @ 105C		m.eq/100g @ 105C					% @ 80C			% @ 105C		@ 40C		m.eq/100g @ 105C			@ 40C
B 0.10	8.6	.20	.001												5.0							
0.10	8.7	.14	.002	7	21	14 59	46	35	13	.34	.69	.037	.091	.043	5.0	18	.32					
0.20	8.7	.17	.003												5.8							
0.30	8.6	.21	.003	3	21	15 58	46	34	15	.72	.21	.029	.040	.045	6.0	19	.34					
0.40	8.9	.19	.002												6.1							
0.50	8.9	.21	.001												4.8							
0.60	8.9	.27	.001	7	21	12 61	44	26	17	2.5	.07	.015	.006	.030	4.6	18	.36					
0.70	8.0	1.7	.002												5.0							
0.80	7.9	2.8	.003												5.9							
0.90	7.9	3.1	.007	6	19	12 64	46	26	18	5.0	.09	.015	.011	1.24	6.3	19	.37					
1.00	7.8	3.3	.015												6.8							
1.10	7.8	3.4	.025												7.5							
1.20	7.8	3.5	.038	6	19	10 63	42	23	19	7.2	.10	.019	.020	1.83	5.9							
1.30	7.8	3.7	.056												5.4							
1.40	7.8	2.9	.076												5.9							
1.50	7.9	1.7	.111												6.8							

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Extr. P Bicarb.	HCl K	CaCl2 Extr K	CaCl2 Extr P	DTPA-extr. Fe	DTPA-extr. Mn	DTPA-extr. Cu	DTPA-extr. Zn	DTPA-extr. B	Extractable SO4S	Extractable NO3N	Extractable NH4N	P Buff Cap	P Equil	Alternative Cations CEC	Alternative Cations Ca	Alternative Cations Mg	Alternative Cations Na	Alternative Cations K
metres	% @ 105C	% @ 105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C		mg/kg @ 105C					mg/kg @ 105C			@ 40C	ug/L	m.eq/100g @ 105C				
B 0.10	1.0	.09	17	14	.55			14	6	1.0	0.3											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Villafranca**

SITE NO: S26 A.M.G. REFERENCE: 589 600 mE 7 546 700 mN ZONE 55

GREAT SOIL GROUP: Red earth
PRINCIPAL PROFILE FORM: Gn2.12
SOIL TAXONOMY UNIT: Torrox
FAO UNESCO UNIT: Orthic Ferralsol?

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Nil

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Tall open woodland
DOMINANT SPECIES: Eucalyptus polycarpa, Eucalyptus papuana, Eucalyptus erythrophloia, Eucalyptus drepanophylla, Bursaria incana, Aristida species, Heteropogon contortus

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Hard setting

HORIZON	DEPTH	DESCRIPTION
A11	0 to .03 m	Dull reddish brown (2.5YR4/4) moist, bright reddish brown (5YR5/6) dry; no mottles; clay loam, sandy; no coarse fragments; massive; dry; very firm; no segregations. Clear to-
A12	.03 to .25 m	Reddish brown (10R4/4) moist; no mottles; clay loam,sandy; no coarse fragments; weak; dry; very firm; no segregations. Diffuse to-
B2	.25 to 1.30 m	Red (10R4/6) moist; no mottles; sandy clay; few small pebbles, subrounded gravel; weak; dry; very firm; no segregations. Clear to-
D	1.30 to 1.50 m	Very abundant medium pebbles, rounded gravel; no segregations.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS % @ 105C	S %	C %	Exch. Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K	Total Elements P % @ 80C	K %	S %	Moistures ADM 33* % @ 105C	1500* %	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
B 0.10	6.7	.05	.002				6	3.9	1.5	.04	.83											
0.10	6.0	.04	.001	25	43	8 25	6	2.6	1.3	.02	.62	.034	.241	.024	1.1	7	.37					
0.20	6.0	.04	.001																			
0.30	6.3	.03	.001	23	41	5 31	4	2.4	1.1	.02	.48	.034	.239	.023	1.0	8	.28					
0.40	6.4	.03	.002																			
0.50	6.5	.03	.002																			
0.60	6.5	.03	.002	21	38	6 37	5	3.3	1.4	.02	.39	.027	.275	.010	1.1	9	.24					
0.70	6.5	.02	.002																			
0.80	6.4	.02	.001																			
0.90	6.3	.02	.001	21	38	6 36	3	1.8	1.3	.02	.25	.028	.283	.012	1.2	9	.11					
1.00	6.3	.02	.001																			
1.10	6.5	.02	.001																			
1.20	6.6	.02	.001	20	39	6 30	4	1.7	1.8	.02	.18	.026	.262	.009	1.2							
1.30	6.9	.02	.001																			
1.40	6.9	.02	.001																			
1.50	7.1	.02	.001																			
1.60	7.3	.03	.001	35	29	7 27	5	2.0	2.4	.02	.17	.039	.148	.011	1.5							

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb.	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	Fe	DTPA-extr. Mn	Cu	Zn	B	Extractable SO4S mg/kg @ 105C	NO3N	NH4N	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K
B 0.10	0.7	.04		5	.76			18	54	0.9	0.1											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 7 CEC method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Violet**

SITE NO: S54 A.M.G. REFERENCE: 584 400 mE 7 536 800 mN ZONE 55

GREAT SOIL GROUP: Lithosol
PRINCIPAL PROFILE FORM: Uc1.21
SOIL TAXONOMY UNIT: Lithic Torriorthent
FAO UNESCO UNIT: Haplic Xerosol

SLOPE: 2 %
LANDFORM ELEMENT TYPE: Hillcrest
LANDFORM PATTERN TYPE: Undulating low hills

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Few cobbles, subangular fragments same as substrate material

DISTURBANCE OF SITE: Extensive clearing
VEGETATION
STRUCTURAL FORM: Tall open woodland
DOMINANT SPECIES: Eucalyptus crebra, Acacia leiocalyx, Aristida species, Themeda australis

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Hard setting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .15 m	Greyish brown (5YR4/2) moist, greyish brown (7.5YR6/2) dry; no mottles; coarse sandy loam; many medium pebbles, subangular, very few coarse pebbles, angular; massive; wet; very weak; no segregations

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS	FS	S	C % @ 105C	Exch. Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C	Total Elements P % @ 80C	K % @ 80C	S % @ 80C	Moistures ADM 33* % @ 105C	1500* % @ 105C	Disp.Ratio R1 @ 40C	R2 @ 40C	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC @ 105C	pH CaCl2 @ 40C
B 0.10	6.1	.03	.002																				
0.15	5.8	.03	.024	44	40	9	8	6	1.8	1.0	.05	.53	.019	1.74	.012	0.3	4	.65					

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Extr. mg/kg @ 105C	Acid Extr. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P mg/kg @ 105C	DTPA-extr. Fe mg/kg @ 105C	Mn	Cu	Zn	B	Extractable SO4S mg/kg @ 105C	NO3N mg/kg @ 105C	NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L @ 40C	Alternative Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K
B 0.10	0.7	.06	5	2	.50			28	29	0.1	0.3											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 7
CEC method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Well**

SITE NO: S4 A.M.G. REFERENCE: 553 400 mE 7 559 000 mN ZONE 55

GREAT SOIL GROUP: Red-brown clay
PRINCIPAL PROFILE FORM: Ug5.38
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Mid slope
LANDFORM PATTERN TYPE: Gently undulating rises

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: .10 m
HORIZONTAL INTERVAL: 4 m
COMPONENT OF MICRORELIEF SAMPLED: Mound
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded quartz

DISTURBANCE OF SITE: Limited clearing
VEGETATION
STRUCTURAL FORM: Mid-high open forest
DOMINANT SPECIES: Acacia cambagei, Eremophila mitchellii, Acacia harpophylla, Carissa ovata, Ehretia membranifolia

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .05 m	Dull reddish brown (5YR4/4) moist, dull reddish brown (5YR4/3) dry; no mottles; medium clay; no coarse fragments; strong 2-5mm subangular blocky secondary, parting to weak <2mm granular primary; dry; loose; few medium carbonate nodules. Clear to-
B21	.05 to .50 m	Dull reddish brown (5YR4/4) moist; no mottles; medium heavy clay; very few small pebbles, subrounded quartz; strong 20-50mm subangular blocky secondary, parting to strong 10-20mm lenticular primary; dry; very firm; few fine carbonate nodules, very few medium carbonate soft segregations. Clear to-
B22	.50 to .80 m	Dull reddish brown (5YR4/4) moist; no mottles; medium heavy clay; very few small pebbles, subrounded silt; lenticular; dry; very firm; few fine gypseous crystals, very few fine carbonate soft segregations. Gradual to-
B23	.80 to 1.15 m	Dull reddish brown (5YR4/4) moist; no mottles; medium heavy clay; no coarse fragments; lenticular; dry; very firm; common coarse gypseous crystals, common medium manganiferous veins. Gradual to-
B24	1.15 to 1.50 m	Reddish brown (5YR4/6) moist; no mottles; medium heavy clay; no coarse fragments; lenticular; dry; very firm; common fine manganiferous veins, very few medium gypseous crystals. Clear to-
B25	1.50 to 1.60 m	Bright reddish brown (5YR5/6) and reddish brown (5YR4/6) moist; medium heavy clay; no coarse fragments; lenticular; dry; very firm; no segregations.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM 33*	1500*	Disp.Ratio R1 @ 40C	R2	Exch Al	Exch Acid	ECEC	pH CaCl2 @ 40C
metres				%				m.eq/100g @ 105C					% @ 80C			% @ 105C				m.eq/100g @ 105C			
B 0.10	7.8	.20	.003																				7.2
0.10	7.9	.16	.002	05	14	15	68	57	39	16	.36	.57	.06	.09	.08	5.8	22	.27					7.4
0.20	8.3	.26	.005																				7.6
0.30	8.5	.30	.007	04	14	13	70	54	34	20	3.0	.11	.01	.01	.10	5.9	22	.32					7.9
0.40	8.6	.40	.016																				7.9
0.50	8.5	.66	.033																				7.9
0.60	8.0	1.8	.048	03	14	16	71	56	32	24	6.7	.05	.04	.02	.34	7.4	23	.36					7.8
0.70	7.8	2.8	.063																				7.8
0.80	7.7	3.2	.077																				7.7
0.90	7.6	3.6	.085	03	14	09	74	57	30	23	8.4	.05	.03	.02	.91	6.0	24	.28					7.7
1.00	7.3	4.0	.091																				7.6
1.10	7.0	4.1	.111																				7.3
1.20	6.7	4.1	.129	06	08	07	77	58	29	21	8.6	.07	.03	.03	1.32	6.6	25	.34					6.8
1.30	6.0	3.1	.149																				6.0
1.40	5.4	2.5	.155																				5.3
1.50	5.2	2.6	.160	01	12	11	75	59	27	20	8.8	.09	.04	.03	.31	6.4	27	.46					5.2

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid	Bicarb.	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K
metres			mg/kg @ 105C					mg/kg @ 105C								m.eq/100g @ 105C				
B 0.10	1.1	.10	12	15	.31			16	14	1.3	0.5									
0.10																39	15	.36	.56	
0.30																42	20	3.5	.13	
0.60																45	25	9.2	.09	
0.90																79	22	10	.05	
1.20																87	20	11	.07	
1.50																31	20	12	.10	

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol
Alternative cation method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Well**

SITE NO: S5 A.M.G. REFERENCE: 553 400 mE 7 559 000 mN ZONE 55

GREAT SOIL GROUP: Red-brown clay
PRINCIPAL PROFILE FORM: Ug5.3
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Mid slope
LANDFORM PATTERN TYPE: Gently undulating rises

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: .10 m
HORIZONTAL INTERVAL: 4 m
COMPONENT OF MICRORELIEF SAMPLED: Depression
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded quartz

VEGETATION
STRUCTURAL FORM: Mid-high open forest
DOMINANT SPECIES: Acacia cambagei, Eremophila mitchellii, Acacia harpophylla, Carissa ovata, Ehretia membranifolia

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .05 m	Brown (7.5YR4/3) moist, brown (7.5YR4/3) dry; no mottles; medium heavy clay; very few small pebbles, subrounded quartz; moderate 2-5mm subangular blocky secondary, parting to strong <2mm granular primary; dry; loose; very few medium carbonate nodules. Clear to-
B21	.05 to .50 m	Brown (7.5YR4/3) moist; no mottles; medium heavy clay; no coarse fragments; moderate 5-10mm subangular blocky; dry; moderately strong; few medium carbonate nodules. Gradual to-
B22	.50 to 1.00 m	Brown (7.5YR4/3) moist; few fine distinct grey mottles; medium heavy clay; no coarse fragments; dry; moderately strong; common medium gypseous crystals, few fine manganiferous veins. Gradual to-
B23	1.00 to 1.40 m	Dull reddish brown (5YR4/4) moist; no mottles; medium heavy clay; no coarse fragments; dry; moderately strong; few medium gypseous crystals, common medium manganiferous veins. Clear to-
B24	1.40 to 1.60 m	Reddish brown (5YR4/6) moist; no mottles; medium heavy clay; few small pebbles, subrounded unspecified coarse fragments; dry; moderately strong; very few medium gypseous crystals.

Depth metres	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P K S % @ 80C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 R2 @ 40C	Exch Exch ECEC Al Acid m.eq/100g @ 105C	pH CaCl2 @ 40C
B 0.10	7.7	.13	.002							7.2
0.10	8.3	.15	.001	07 13 15 70	61 48 15 .76 .42	0.05 .06 .09	5.9 21	.24		7.7
0.20	8.6	.18	.002							7.8
0.30	8.7	.24	.005	06 12 15 0	60 39 17 3.4 .11	.04 .03 .07	6.5 23	.28		7.8
0.40	8.7	.27	.007							7.8
0.50	8.4	.67	.015							7.8
0.60	7.8	3.0	.032	06 09 13 69	58 39 19 6.2 .07	.04 .02 1.18	7.0 22	.12		7.7
0.70	7.7	3.6	.048							7.7
0.80	7.7	3.7	.059							7.7
0.90	7.7	3.7	.071	03 09 12 77	58 31 21 8.2 .05	.03 .02 1.36	6.6 24	.23		7.7
1.00	7.2	3.9	.090							7.2
1.10	6.2	3.1	.105							6.3
1.20	5.5	3.9	.119	02 11 12 77	58 27 19 8.1 .09	.03 .02 .95	6.9 26	.39		5.5
1.30	5.3	3.4	.126							5.2
1.40	5.2	2.0	.141							5.0
1.50	5.0	2.3	.147	01 10 06 81	60 24 18 8.8 .08	.05 .03 .29	8.2 28	.48		4.9

Depth metres	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe Mn Cu Zn B mg/kg @ 105C	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC Ca Mg Na K m.eq/100g @ 105C
B 0.10	1.2	.11	8 12	.33			15 16 1.3 0.5				
0.10											49 14 .87 .39
0.30											44 15 3.5 .12
0.60											70 18 7.5 .09
0.90											74 20 9.8 .06
1.20											60 19 11 .09
1.50											30 19 12 .10

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol
Alternative cation method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Well, footslope variant**

SITE NO: S7 A.M.G. REFERENCE: 554 000 mE 7 561 800 mN ZONE 55

GREAT SOIL GROUP: Brown clay
PRINCIPAL PROFILE FORM: Ug5.3
SOIL TAXONOMY UNIT: Typic Torrert
FAO UNESCO UNIT: Chromic Vertisol

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Flat
LANDFORM PATTERN TYPE: Level plain

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: .10 m
HORIZONTAL INTERVAL: 10 m
COMPONENT OF MICRORELIEF SAMPLED: Mound
SURFACE COARSE FRAGMENTS: Very few small pebbles, subrounded quartz

DISTURBANCE OF SITE: No effective disturbance other than grazing
VEGETATION
STRUCTURAL FORM: Mid-high open forest
DOMINANT SPECIES: Acacia cambagei, Eremophila mitchellii

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Periodic cracking, self-mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .07 m	Dull reddish brown (5YR4/3) moist; no mottles; medium heavy clay; no coarse fragments; moderately moist; moderately firm; no segregations. Abrupt to-
B21	.07 to .40 m	Dull reddish brown (5YR4/3) moist; no mottles; heavy clay; no coarse fragments; dry; moderately strong; common medium gypseous crystals, few fine manganiferous veins. Clear to-
B22	.40 to .80 m	Dull reddish brown (5YR4/3) moist; no mottles; heavy clay; very few small pebbles, subrounded quartz; dry; moderately strong; common medium gypseous crystals. Abrupt to-
B23	.80 to 1.30 m	Dull reddish brown (5YR4/3) moist; no mottles; heavy clay; no coarse fragments; dry; very firm; few medium gypseous crystals. Diffuse to-
D?	1.30 to 1.80 m	Greenish grey (10GY5/1) moist, red (10R4/6) moist; common medium distinct brown mottles; heavy clay; no coarse fragments; dry; very firm; very few medium gypseous crystals.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM 33*	1500*	Disp.Ratio R1	R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres		dS/m	%		%			m.eq/100g						%			%				m.eq/100g		
	@ 40C	@105C		@ 105C				@ 105C					@ 80C			@ 105C		@ 40C			@ 105C		@ 40C
B 0.10	6.7	.76	.010																				6.6
0.10	6.8	.63	.003	06	29	18	51	28	21	5.3	.50	.19	.02	.01	.17	4.4	21	.47					6.6
0.20	6.1	2.7	.025																				6.2
0.30	5.5	3.2	.060	05	30	16	54	26	16	8.4	2.6	.04	.02	.01	.47	4.8	15	.36		0.01	0.04		5.5
0.40	5.0	3.4	.079																				5.1
0.50	4.6	3.7	.103																				4.7
0.60	4.4	3.3	.110	04	26	16	57	27	12	9.8	4.8	.03	.01	.01	1.45	5.2	15	.52		0.28	0.42		4.4
0.70	4.3	3.8	.120																				4.3
0.80	4.1	3.9	.148																				4.1
0.90	4.2	2.8	.158	03	21	17	64	30	11	9.5	5.3	.04	.01	.01	.36	5.5	17	.48		0.87	1.04		4.1
1.00	4.2	2.3	.173																				4.0
1.10	4.1	2.6	.190																				4.0
1.20	4.2	2.3	.169	02	19	15	65	31	11	9.6	5.4	.04	.01	.01	.19	6.3	20	.47		1.34	1.53		4.0
1.30	4.2	2.1	.189																				4.0
1.40	4.0	2.9	.200																				3.9
1.60	4.2	2.3	.213	01	15	13	73	42	14	14	8.5	.04	.01	.01	.10	7.5		.49		2.23	2.32		3.9

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid	Bicarb.	HCl K meq% @105C	CaCl2 Extr K	P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil ug/L @ 40C	Alternative Cations CEC	Ca	Mg	Na	K
metres			mg/kg @ 105C			mg/kg @ 105C		mg/kg @ 105C					mg/kg @ 105C					m.eq/100g @ 105C				
B 0.10	0.7	.06	7	6	.19			15	27	1.0	0.4											
0.10																		38	29	6.1	.60	.20
0.30																		63	47	9.2	4.0	.04
0.60																		59	36	12	8.0	.04
0.90																		45	21	12	9.6	.05
1.20																		48	20	13	10	.05
1.60																		53	17	16	13	.04

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol
Alternative cation method: Extraction with 1M NH_4Cl at pH 7 Alternative CEC method: Extraction with 1M NH_4Cl at pH 7

SOIL TYPE: **Windradene**

SITE NO: S47 A.M.G. REFERENCE: 590 000 mE 7 523 500 mN ZONE 55

GREAT SOIL GROUP: Rendzina
PRINCIPAL PROFILE FORM: Uf6.32
SOIL TAXONOMY UNIT: Mollisol
FAO UNESCO UNIT: Rendzina

SLOPE: 0 %
LANDFORM ELEMENT TYPE: Crest
LANDFORM PATTERN TYPE: Gently undulating rises

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Many medium pebbles, subangular limestone

DISTURBANCE OF SITE: Extensive clearing
VEGETATION
STRUCTURAL FORM: Mid-high open shrubland
DOMINANT SPECIES: Erythroxylon australe, Canthium species, Apophyllum anomalum

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Firm, self-mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .01 m	Brownish black (7.5YR3/1) moist, greyish yellow-brown (10YR4/2) dry; no mottles; light clay; no coarse fragments; moderate <2mm subangular blocky; dry; loose; no segregations.
B2	.01 to .10 m	Brownish black (7.5YR3/1) moist; no mottles; light medium clay; no coarse fragments; dry; very firm; no segregations.
C1	.10 to .40 m	Very abundant cobbles, subrounded limestone; no segregations.
C2	.40 to .60 m	Many medium pebbles, subrounded limestone; very many carbonate soft segregations.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @105C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P K S % @ 80C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 R2 @ 40C	Exch Exch ECEC Al Acid m.eq/100g @ 105C	pH CaCl2 @ 40C
B 0.10	8.5	.16	.002							
0.10	8.6	.15	.001	30 25 12 29	32 28 4.5 .20 .85	.078 .528 .092	3.5 16	.56		
0.20	8.6	.20	.002							
0.30	8.7	.17	.003	39 15 15 29	14 13 3.2 .11 .24	.060 .184 .049	1.8 14	.49		
0.40	8.8	.14	.003							
0.50	8.9	.13	.002							
0.60	8.9	.11	.001	16 17 27 39	12 10 3.8 .10 .17	.048 .096 .042	1.6 12	.53		

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb.	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe Mn Cu Zn B mg/kg @ 105C	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC Ca Mg Na K m.eq/100g @ 105C
B 0.10	2.3	.25	126	17	.71			9.3 17 .51 .49				

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Winvic**

SITE NO: S45 A.M.G. REFERENCE: 557 800 mE 7 515 300 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Dr2.12
SOIL TAXONOMY UNIT: Lithic Torriorthent
FAO UNESCO UNIT: Haplic Xerosol

SLOPE: 3 %
LANDFORM ELEMENT TYPE: Upper slope
LANDFORM PATTERN TYPE: Gently undulating rises

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Common coarse pebbles, subangular quartz

DISTURBANCE OF SITE: Complete clearing
VEGETATION
STRUCTURAL FORM: Tall open shrubland
DOMINANT SPECIES: Eremophila mitchellii, Acacia harpophylla, Cenchrus ciliaris

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Hard setting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .08 m	Dark reddish brown (2.5YR3/3) moist; no mottles; clay loam,sandy; many medium pebbles, subangular quartz, very few coarse pebbles, subangular quartz; massive; moderately moist;; no segregations. Abrupt to-
B2	.08 to .25 m	Dark reddish brown (2.5YR3/4) moist; no mottles; light medium clay; many medium pebbles, subangular quartz, very few coarse pebbles, subangular quartz; moist; moderately firm; no segregations.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P K S % @ 80C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 R2 @ 40C	Exch Exch ECEC Al Acid m.eq/100g @ 105C	pH CaCl2 @ 40C
metres										
B 0.08	6.8	.08	.001							
0.08	8.0	.11	.001	27 39 13 22	14 13 1.2 .12 .83	.181 1.10 .037	0.6 10	.69		
0.25	8.2	.09	.001	25 40 10 25	11 9.3 0.8 .08 .35	.097 1.17 .019	0.6 8	.82		

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe Mn Cu Zn B mg/kg @ 105C	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Cap Equil ug/L @ 40C	Alternative Cations CEC Ca Mg Na K m.eq/100g @ 105C
metres										
B 0.08	1.7	.12	147 76	.83		45	12 1.1 1.7			

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

SOIL TYPE: **Yackadoo**

SITE NO: S53 A.M.G. REFERENCE: 567 300 mE 7 519 300 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Uf6.53
SOIL TAXONOMY UNIT: Lithic Torriorthent
FAO UNESCO UNIT: Haplic Xerosol

SLOPE: 2 %
LANDFORM ELEMENT TYPE: Upper slope
LANDFORM PATTERN TYPE: Gently undulating rises

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Many medium pebbles, subangular quartz

DISTURBANCE OF SITE: Complete clearing
VEGETATION
STRUCTURAL FORM: Tall isolated shrubs
DOMINANT SPECIES: Eremophila mitchellii, Apophyllum anomalum, Cenchrus ciliaris

PROFILE MORPHOLOGY:

CONDITION OF SURFACE SOIL WHEN DRY: Hard setting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .07 m	Dark reddish brown (5YR3/4) moist; no mottles; light clay; many medium pebbles, subrounded quartz, few coarse pebbles, subrounded quartz; massive; dry; moderately weak; very few fine carbonate soft segregations. Clear to-
B2	.07 to .25 m	Reddish brown (5YR4/6) moist; no mottles; light clay; abundant medium pebbles, subrounded quartz, few coarse pebbles, subrounded quartz; massive; dry; moderately weak; very few fine carbonate soft segregations.

Depth metres	1:5 Soil/Water pH @ 40C	EC dS/m @105C	Cl % @105C	Particle Size CS FS % @ 105C	S % @ 105C	C % @ 105C	Exch. Cations CEC m.eq/100g @ 105C	Ca m.eq/100g @ 105C	Mg m.eq/100g @ 105C	Na m.eq/100g @ 105C	K m.eq/100g @ 105C	Total Elements P % @ 80C	K % @ 80C	S % @ 80C	Moistures ADM % @ 105C	33* % @ 105C	1500* % @ 105C	Disp.Ratio R1 @ 40C	R2 @ 40C	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC m.eq/100g @ 105C	pH CaCl2 @ 40C
B 0.07	8.2	.14	.002																				
0.07	8.0	.13	.001	22	33	16	30	21	17	2.4	.08	1.3	.162	1.77	.050	1.0		10	.65				

Depth metres	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P mg/kg @ 105C	DTPA-extr. Fe mg/kg @ 105C	Mn mg/kg @ 105C	Cu mg/kg @ 105C	Zn mg/kg @ 105C	B mg/kg @ 105C	Extractable SO4S mg/kg @ 105C	NO3N mg/kg @ 105C	NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca m.eq/100g @ 105C	Mg m.eq/100g @ 105C	Na m.eq/100g @ 105C	K m.eq/100g @ 105C
B 0.07	2.6	.24	130	41	1.6			17	10	1.2	0.7											

* -33kPa (-0.33bar) and -1500kPa (-15 bar) using pressure plate apparatus.
Cation method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol CEC method: Extraction with 1M NH_4Cl at pH 8.5 in 60% ethanol

APPENDIX IV

A LIST OF PLANT SPECIES

Trees and shrubs

Common name	Scientific name
Bancroft's wattle	*Acacia bancroftii*
Bauhinia, red flowered	*Lysiphyllum caronii*
Bauhinia, white flowered	*L. hookeri*
Bendee	*Acacia catenulata*
Bitter bark [W,P]	*Alstonia constricta*
Black tea tree	*Melaleuca bracteata*
Black wattle	*Acacia leiocalyx*
Boonaree	*Heterodendrum oleifolium*
Boree	*Acacia tephrina*
Bottletree	*Brachychiton rupestris*
Brigalow	*Acacia harpophylla*
Broad leaved bottletree	*Brachychiton australis*
Broom bush	*Apophyllum anomalum*
Coolibah	*Eucalyptus coolabah*
Cumby cumby	*Pittosporum phylliraeoides*
Currant bush	*Carissa ovata*
Dawson gum	*Eucalyptus cambageana*
Dead finish	*Albizia basaltica*
Ellangowan poison bush [P]	*Myoporum deserti*
Emu apple	*Owenia acidula*
False sandalwood	*Eremophila mitchellii*
Fuschia bush [P]	*E. maculata*
A geebung	*Persoonia falcata*
Ghost gum	*Eucalyptus papuana*
Gidgee	*Acacia cambagei*
Gooramurra	*Eremophila bignoniflora*
Gum topped bloodwood	*Eucalyptus erythrophloia*
Gundabluie	*Acacia victoriae*
Inland bloodwood	*Eucalyptus terminalis*
Ironwood	*Acacia excelsa*
Kurrajong	*Brachychiton populneus*
Lancewood	*Acacia shirleyi*
Leichhardt bean	*Cassia tomentella var.brewsteri*
Lemon scented gum	*Eucalyptus citriodora*
Limebush	*Eremocitrus glauca*
Long fruited bloodwood	*Eucalyptus dolichocarpa*
Medicine bush	*Coelospermum reticulatum*
Mimosa bush	*Acacia farnesiana*
Moreton Bay ash	*Eucalyptus tessellaris*
Mountain coolibah	*E. orgadophila*
Myall	*Acacia pendula*
Myrtle tree	*Canthium oleifolium*
Narrow leaf bumble-tree	*Capparis loranthifolia*
Narrow leaved ironbark	*Eucalyptus crebra*
Nipan	*Capparis lasiantha*
Peachbush	*Ehretia membranifolia*

Common name	Scientific name
Poplar box	*Eucalyptus populnea*
Prickly pine	*Bursaria incana*
Queensland grey ironbark	*Eucalyptus drepanophylla*
Quinine berry	*Petalostigma pubescens*
Red ash	*Alphitonia excelsa*
Reid River box	*Eucalyptus brownii*
Rosewood	*Acacia rhodoxylon*
Sally wattle	*A. salicina*
Scrub boonaree	*Heterodendrum diversifolium*
Scrub leopardwood	*Flindersia dissosperma*
Silver leaved ironbark	*Eucalyptus melanophloia*
Tea trees	*Melaleuca species*
True sandalwood	*Sandalum lanceolatum*
A turkey bush	*Erythroxylum australe*
Vine tree or supplejack	*Ventilago viminalis*
Wallaby apple	*Citriobatus spinescens*
Wattles	*Acacia species*
Whitewood	*Atalaya hemiglauca*
Wilga	*Geijera parviflora*
Yapunyah	*Eucalyptus thozetiana*
Yellow jacket	*E. leichardtii*
Yellowwood [P]	*Terminalia oblongata*
Grasses and forbs	
Barbed wire grass	*Cymbopogon refractus*
Bellvine [W]	*Ipomoea plebeia*
Black or bunch speargrass	*Heteropogon contortus*
Bluegrasses	*Bothriochloa species*
Bluegrasses	*Dichanthium species*
Boggabri [W]	*Amaranthus mitchellii*
Brigalow grass	*Paspalidium caespitosum*
Buck spinifex	*Triodia mitchellii*
Coolibah grass	*Thellungia advena*
Couch grass [W]	*Cynodon dactylon*
Cowvine [W]	*Ipomoea lonchophylla*
Curly windmill grass	*Enteropogon acicularis*
Desert bluegrass	*Bothriochloa ewartiana*
Fairy grass, Yakka grass	*Sporobolus caroli*
Flinders grasses	*Iseilema species*
Hooky grass	*Ancistrachne uncinulata*
Kangaroo grass	*Themeda trianda*
Lovegrasses	*Eragrostis species*
Mexican poppy [W]	*Argemone species*
Mitchell grasses	*Astrebla species*
Native jute [W]	*Corchorus trilocularis*
Native millet	*Panicum decompositum*
Noogoora burr [W,P]	*Xanthium pungens*
Para grass	*Brachiaria mutica*
Parthenium [W]	*Parthenium hysterophorus*
Peak Downs curse [W]	*Polymeria longifolia*
Pimelea [P]	*Pimelea species*
Pitted bluegrass	*Bothriochloa decipiens var. decipiens*

Common name	Scientific name
Potato weed [W]	*Solanum ellipticum*
Poverty grass	*Eremochloa bimaculata*
Purple pigeon grass	*Setaria incrassata*
Queensland bluegrass	*Dichanthium sericeum*
Raspweed [W]	*Haloragis aspera*
Rattlepod [W]	*Crotalaria dissitiflora*
Seca stylo	*Stylosanthes scabra* cv. *Seca*
Silk sorghum	*Sorghum halpense* X *S.roxburghii* X *S.arundinaceum*
Siratro	*Macroptilium atropurpureum*
Slender chloris	*Chloris divaricata*
Slender panic	*Panicum gracile*
Teucry weed [W]	*Teucrium integrifolium*
Thornapple [W]	*Datura species*
Townsville stylo	*Stylosanthes humilis*
Wild rosella [W]	*Abelmoschus ficulneus*
Wiregrasses	*Aristida species*
Wynn cassia	*Cassia rotundifolia*
Yabila grass	*Panicum queenslandicum*

[W] These plants are common weeds, particularly of cultivated areas
[P] These plants are suspected as being poisonous to stock